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Cynthia Valencic, Editor

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Legal Environmental Assistance Foundation

THERE IS NO AWAY

An Interdisciplinary Conference
on
Waste Reduction, Reuse, and Disposal Alternatives

PROCEEDINGS

Strategies
for the
Comprehensive Management
of
Domestic, Municipal and Hazardous Wastes

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Florida Department of Environmental Regulation
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PREFACE

Improper management of domestic, municipal, and hazardous waste threatens the health and environment of any state. Florida is especially vulnerable because of the state's hydrogeology and dependence on ground water for drinking water. At this time, Florida primarily relies on out-of-state capacity for its waste disposal. Florida is heavily dependent on Alabama facilities to manage its hazardous waste. It is essential that Florida develop and implement a system to manage the state's waste before it further endangers the environment and health of Florida's citizens. At the same time, Florida's assumption of its own management capacity will reduce the incidence of spills and leaks during waste transportation and help alleviate the national shortfall of disposal capacity.

In order to promote sound management of waste in Florida and in other states, the Legal Environmental Assistance Foundation (LEAF) undertook a three-part project which sought to bring together diverse perspectives to discuss solutions to hazardous waste management problems. The first part of this project involved the development of a model hazardous waste collection and transfer system in Florida. During this phase, four technical reports were generated regarding the conceptualization and implementation of the model collection/transfer system. The second part of this project involved a conference entitled "Finding Common Ground: A Conference for Developing Cooperative Solutions to Hazardous Waste Problems" held for the purpose of developing cooperative solutions for hazardous waste problems. The final part of this project involved a conference for promoting a comprehensive approach to solving Florida's waste problem. "There Is No Away: An Interdisciplinary Conference on Waste Reduction, Reuse and Disposal Alternatives" offered a forum for the presentation of information, exchange of ideas and concerns, and the development of a network to implement solutions to the problem of what to do with hazardous waste in Florida. Information presented at this conference is provided in these proceedings.

Summaries of the three parts of LEAF's project are provided to place the proceedings presented here in perspective of the total project.

Part One: Model Hazardous Waste Collection and Transportation System

In order to fully implement federal and state laws designed to protect the health and environment from hazardous waste, facilities utilizing the most advanced and safest technologies must be made available and accessible to all generators of hazardous waste. Without such facilities, waste are disposed of illegally or improperly. It is now evident that environmental contamination is caused by numerous sources, including small quantity and household generators of hazardous waste. Small businesses which produce a few barrels of hazardous waste a month do not have ready access to proper hazardous waste management capacity. In addition, many household items such as paint cans, cleaning items and fertilizer are put in the trash and end up in a local municipal landfill. To address this problem, LEAF, through its consultant, ERM-South, Inc., undertook a study to develop a model hazardous waste collection and transporation system for northeast Florida. The information developed in this pilot project has been applied on a statewide basis.

Utilizing data and information collected while performing a local hazardous waste assessment pursuant to the Water Quality Assurance Act of 1983, LEAF/ERM surveyed nearly 6,000 businesses in a seven county region in 1984. The results of the 1984 survey were statistically extrapolated to yield present day estimates of hazardous waste production by large quantity generators, small quantity generators and household generators.

Using this data base and industry contacts made during the assessment, LEAF undertook several follow-up steps. LEAF assessed the interest in a collection and transportation system by businesses in the area. LEAF/ERM developed several designs for a collection and transportation system and analyzed in detail the most feasible design. LEAF/ERM reviewed the environmental and economic implications of that collection and transportation system. Finally, LEAF/ERM investigated measures to facilitate implementation of the collection and transportation system.

The conclusion and the results of this study show a definite need for a collection and transporation system in Florida. This study recommended the following:

1. Considering the level of uncertainty and the exact composition of waste addressed in the study, a pilot waste collection system should be undertaken as an initial step.

2. Incentives and payment alternatives should be examined during the pilot program. Given that behavioral modifications will be required (i.e. to accustom generators to the proper disposal of their waste through a collection system rather than continue using past mismanagement methods), some possible incentives are:

   o Ad valorem taxes on commercial and industrial firms;

   o Taxes on virgin chemicals;

   o Subsidization from general revenue; and

- A phase-in period in which businesses will not pay the full cost of collection and disposal.

3. Continued education efforts are needed to further increase the public's awareness of the problem. Extensive public education needs to occur to further inform the small quantity generators of the responsibility for properly managing their waste.

4. Public officials in the area should take the lead in finding appropriate solutions to the problem. Local and regional councils, mayors, county managers and others in charge of administering or affecting disposal services for other non-hazardous types of waste can make valuable contributions in finding solutions.

5. Additional enforcement action is needed to bring these generators into compliance.

6. Further research is needed in additional areas, such as:

   - Determine how a collection and transportation system can help reduce dependence on land disposal by encouraging alternative technologies;

   - Assess the feasibility of local recycling and/or treatment facilities to provide a supply of waste management services;

   - Evaluate methods to manage hazardous wastes from households and very small quantity generators who are commingling the waste and disposing of it through a lab-pack into a landfill.

   - Evaluate methods to achieve source separation for household and very small quantity generator wastes.

As part of this project, four documents and an executive summary were generated. These documents can be obtained from the Legal Environmental Assistance Foundation, 203 North Gadsden Street, Suite 7, Tallahassee, Florida 32301 and are entitled: (1) Executive Summary to the Study of Hazardous Waste Collection/Transfer System for the Northeast Florida Region; (2) Study of Hazardous Waste Collection/Transfer System for the Northeast Florida Region; (3) Conceptual Design and Economic Analysis for a Hazardous Waste Collection/Transfer System for the Northeast Florida Region; (4) Environmental Review and Regulatory Analysis for a Hazardous Waste Collection/Transfer System for the Northeast Florida Region; and (5) Measures to Facilitate Implementation of the Collection and Transportation System.

Part Two: Alabama Hazardous Waste Conference

Alabama is performing a vital role in the nation's management of hazardous waste by hosting a major hazardous waste disposal facility. Because of the potential environmental and health ramifications of hosting such a facility, Alabama citizens need to be aware of the role they can play in promoting the safest management of hazardous waste in Alabama. This role includes encouraging other states to develop their own safe hazardous waste management methods in order to reduce the amount of out-of-state hazardous waste shipped to Alabama for disposal. This task of promoting safe hazardous waste mangement requires sufficient knowledge and understanding of federal and state programs regulating hazardous waste. Consequently, LEAF, in conjunction with Troy State University, organized a state conference on the issue.

The conference, entitled "Finding Common Ground: A Conference for Developing Cooperative Solutions to Alabama's Hazardous Waste Problem," was designed to serve as a first step in achieving a greater degree of understanding and cooperation toward improved management of hazardous waste in Alabama. It provided an opportunity for industry, regulators, citizen groups, technical experts, research specialists, and other pertinent interests to meet and work in a proactive rather than reactive manner.

Through the presentations, the first portion of the conference highlighted important areas of hazardous waste management which require greater cooperation and consensus among different interest groups. Areas discussed included Alabama's hazardous waste plan, an update on the Resource Conservation and Recovery Act Amendments, and an unravelling of the complexities of hazardous waste management. The latter sessions allowed participant involvement in exploring differing perspectives on hazardous waste management in Alabama and began the process of consensus building. It involved two different work groups which were entitled, "Clarifying Issues," and "Identifying Solutions."

This conference was put forth as an experiment which might serve as a model for developing greater understanding and cooperation in finding solutions to this and other perplexing environmental problems.

Part Three: Florida Conference on Hazardous Waste

Florida is in the position of suffering from the lack of a state comprehensive waste management capacity, and needs the cooperation of the public and local officials to implement a safe and comprehensive program.

In order to promote sound management of its domestic, municipal, and hazardous waste, numerous diverse Florida organizations joined together to co-sponsor "There Is No Away: An Interdisciplinary Conference on Waste Reduction, Reuse and Disposal Alternatives" on February 28 - March 1, 1986 in Gainesville, Florida. The purpose of this conference was to advance understanding among the public, private and government sectors of the need and methods to implement both solid and hazardous waste systems in Florida. The conference also served to integrate solid and hazardous waste issues. Government officials, industry representatives and concerned citizens provided information on laws and regulations governing waste management, existing and emerging technologies to manage waste, and problems from improper disposal of waste. A full discussion of this conference is provided in these proceedings.

WASTE IN PERSPECTIVE

PRACTICAL SOLUTIONS TO FLORIDA'S WASTE DISPOSAL PROBLEMS

The Honorable George Kirkpatrick
State Senator
District 6

I'm happy to have the opportunity to help kick off this conference, because I think it is very important for this conference to take place in this particular community.

As most of you know, I've traveled around the state for the last few years promoting Amnesty Days, a hazardous waste collection program for small quantity generators. I remember very vividly when we went to Miami to kick off the first Amnesty Days program. We thought that it would be very important for us to get this program launched somewhere where we could get a lot of coverage, so we selected Dade County because of the large media market. What we failed to understand was what the media in Miami was interested in covering; it wasn't Amnesty Days. Not many reporters came and those that came didn't stay long. We worked real hard for four days and to our great surprise, with just a sliver of the market attending, we collected 51,000 lbs. of hazardous waste. We thought it was very successful.

We then went to Pinellas County, Hillsborough County, Orange County and finally, to Alachua County as the last community in the cycle. As a matter of fact, Alachua County wasn't originally in the cycle. It was due to the foresight of our local government here who put up the money and bought us into the first cycle. We were later reimbursed when our turn came around. In Alachua County, we had good treatment in the press. We had a lot of cooperation from volunteer groups in this community. In the three and one-half days that we were in Alachua County (just a fraction of the size of Dade County), we collected 91,000 lbs. of hazardous waste. I think that is a great testimonial to how aware this community is and how willing they are to participate. So, I think it's important that we're here today.

I want to talk for just a few minutes about the state of the problem in Florida. I know that a lot of you out there are experts, but I don't think it hurts us to go over a few numbers from time to time to remind us of just what we're trying to deal with here.

Everybody here is probably aware of how fragile the environment is in Florida. We have a lot of very expansive wetlands and 92 percent of our drinking water comes from underground aquifers. We don't have a lot of easy places to clean up something that we ruin. That's why it's so important that we try to stop it from happening early. The second thing is that we currently generate about 27,000 - 28,000 tons of solid waste in the state everyday. That's an awful lot of waste to have to try and figure out what to do with it. I think it's getting more and more difficult to find a place to put the waste.

As most of you know, I represent a seven county district. I have had a chance to talk with people in Alachua County about the sophistication of resource recovery systems, monitoring wells, and the problems of contamination at the southwest landfill in Archer. I also represent Gilchrist County and I was at their local delegation hearing last week. We were halfway through the conference when one of the county commissioners said, "I don't want to hear about all this other stuff. I want you to tell me what we're going to do about the garbage hole." That's basically the way we all use to think about a landfill, the garbage hole. We didn't care too much about what we were throwing away because it all went into some big hole in the ground and we didn't have to worry about it unless we lived close to it or part of it dropped off in front of our house on the way over there. But it was basically "out of sight out of mind"; we didn't have to worry about it.

Now, we know that's not the case anymore. Gilchrist County's landfill, by the way, is closed today. It flooded. It was built in the wrong place and the stormwater and run-off covered it. They voluntarily closed it, but the Department of Environmental Regulation (DER) hasn't allowed them to re-open it again. So, they're carrying all of their solid waste to Levy County. Fortunately for Gilchrist County, Levy County has a landfill that's working pretty well and they have someplace to take their garbage. If that were not the case, I'm not sure what they would do in Gilchrist County.

Gilchrist County is not a very big place, but it's important to all of us because it sits right on the banks of the Suwannee River. The landfill is located at Bell, Florida which is only about three miles from the edge of the Suwannee River. We know that the aquifer is very close to the surface under Gilchrist County and now their landfill is closed because it's flooded and there is no place to put the garbage. So, many people are just throwing it out in the woods. We can't afford to do that sort of thing.

DER has a new rule for closure of landfills to ensure that when landfills are permanently closed we properly finish the job by using monitoring and other methods that cost money, as much as $100,000 per acre. In Gilchrist County when they finally close their landfill three years from now, it's going to cost them $2.7 million. The total budget for Gilchrist County is only $2.2 million for a year. So, that's a problem that they're not going to be able to solve very easily. I'm told that the same number for Orange County is somewhere around $44 million. That's not going to be an easy problem for Orange County to solve.

We have a significant problem in Florida because we are inundated with a lot of growth. We currently have 11 million people who live in the state. Dr. John DeGrove, the guru of growth management, says we will probably have another 11 million people by the year 2020. Currently, 80 percent of those 11 million people live within 15 miles of the Florida's coast. That's an unbelievable figure. Nine million people in the State of Florida live within 10-15 miles of the coast. It's no wonder that the carrying capacity of the resources along the coast are already used up or on the verge of being used up. You can see that it won't be too long before the carrying capacity will not support any more population. It's one of the reasons the Legislature passed the Coastal Zone section of the Growth Management bill this year. We recognized that something has to be done to discourage and prevent the kind of growth we have along the coastline.

But if, as Dr. DeGrove said, 11 million people will continue to come to Florida, what does that mean for us here in Alachua County or in Kissimmee, Okeechobee, Trenton or elsewhere? It means that the growth will be moving to the interior of the state and with it will come problems. We have 788 people a day that move to Florida. It takes about 110 gallons of new fresh water for these people to drink every day. It takes 100,000 gallons of new waste water that has to be treated everyday. A place has to be found to put 3,500 lbs. of new solid waste. Two miles of road, two school teachers, two classrooms, two prison beds at the state level, one bed at the local level, and two law enforcement officers are needed. That's what 788 people a day means to the State of Florida. Today, we're $29 billion behind in the construction of infrastructure in the state. That's a big number even to us bureaucrats and legislators that deal with a $15 billion budget.

We're going to have to learn to deal with this growth in a lot of new ways. The technology, the thought processes, and the concerns of the past are not going to carry us through this next period. We probably have about five years to get prepared or we're not going to do a very good job. Most of the people in this room have probably come out of Pinellas County on Highway 19, I don't travel that road anymore because I'm scared to death to travel it. I will make an exception to go down there from 11:00 a.m. - 12:00 p.m. on Sunday during church because that's the only time I feel safe driving along the road. But it's a problem. If we allow the rest of the state to develop this way, we will not survive the kinds of problems that we will have.

There are two major long-term problems for the state that we're just now beginning to recognize. The first problem is leaking underground gasoline storage tanks. We estimate there are approximately 66,000 buried tanks in Florida. We estimate that it's 10 percent more than what we think. I, personally, know where two are that nobody else knows about because the person who put them in is dead. So, I know of at least two tanks over what our best estimate is. We have already found 400 of them that are leaking.

The second problem is landfills. We know where most of the landfills are. We like to classify landfills as "terrible, ticking time bombs." I think each one of you should remember it because that's exactly what they are. At the meeting in Archer the other night, the citizens listened to statistical presentations by engineers who are very learned people. But, basically, what the people were interested in was "Can I drink my water?" That's all. They just wanted to know if they could drink their water today, tomorrow, next year or could their kids stay where they lived and continue to drink the water. That's the kind of problem that we will continue to have with our landfills. I don't believe that there is one single landfill in Florida that's not potentially very damaging to our groundwater resources. No matter how good we've been before, I think we have to be much better in the future.

I'm proud to be in Alachua County one more time. As with Amnesty Days, Alachua County is a lot further ahead than most in trying to solve this problem. There are some areas of the state that have already had to address this problem. I think we now have six resource recovery units in the state and there are three more under construction with about 16 in the planning stage. But the number that gets me is the cost of the facilities which is $1.6 billion. Where is that money going to come from? Gilchrist County can never afford one. They can't even afford to close their landfill. There's a lot of technology that we have available and I hope we're going to use some of it.

I want to skip to the thing I like to talk about the most. I don't have a big prepared speech, so I probably won't come off as well as some of the other people, but I'm telling you this from my heart. I believe that the hazardous waste side of the solid waste disposal problem is the most critical. You can look at an old mattress or refrigerator and you can see it sitting out there and it's probably going to sit out there until you and I are gone. But toxic chemicals aren't going to stay there, they're going to go somewhere. If all we had to do was have the U.S. Environmental Protection Agency (EPA) or DER develop strict regulations for large industries and slap them with stiff fines, we'd be all right. However, in our Amnesty Days research as we traveled around the Florida, we found that in some cases 75 percent of the toxic materials in our landfills are coming from homeowners and small generators.

Two years ago, EPA defined a small quantity generator as someone who generated less than 1,000 kilograms a month. I don't know about you, but if you put 12,000 kilograms (12 months at 1,000) in one place on this stage it would look like an awful lot of toxic material to me. In August of this past year, EPA reduced the threshold to 100 kilograms per month. The State of Florida believes that's still too much. In the Water Quality Assurance Act of 1983, we lowered the threshold to zero. That law states that it is unlawful to improperly dispose of any toxic substance in the State of Florida. The problem is that in our rush, we didn't provide proper disposal methods for hazardous waste. So, now we have people storing toxic wastes in their garages and warehouses because we don't have a proper place to dispose of it.

Think about this for a minute. We have the landfill out here. We know we already have a problem with our landfill and we have all this toxic waste being stored with no place to dispose of it. When are the people going to say, "Listen, we don't want this stuff in our garages anymore. Find some place to dump it?" When will they disguise it in a can and get rid of it? When are they going to get a better job, move out of Gainesville, and leave the toxic wastes in their garages so the new owners will bundle it up and get rid of it somewhere? When is this going to happen? It's happening right now almost everyday. I think that's one of the things we have to work on a lot harder. We need to applaud our local government in this community for taking the next step after Amnesty Days and I say that to all you visitors hoping that maybe you'll take some of this back with you to your local community.

Amnesty Days is a program we designed to address the problem of hazardous waste disposal for the homeowner and small quantity generator. It is a one-time disposal of one drum or 450 lbs. of toxic material free of charge. Amnesty Days has three major goals. The first goal is to extract as much material from the environment as possible.

The second goal is to raise the public's level of awareness that we're all individually part of the problem, everyone of us. I like to blame it on my son from time to time. He's like most other 15 year old teenagers with an acne problem. One acne medicine contains a chemical which in large concentrations is toxic. You wouldn't want to drink your water if it contained large concentrations of this chemical. If 25,000 teenagers in this community all decided to throw away the last little bit of medicine on the same day and it went to the same corner of the landfill and deteriorated, we could have a problem from something so innocent as acne medicine. This is the kind of situation with which we're dealing. Some people will say, "Stop selling it." That's nice to say that, but I can tell you my kid wants something done about his face. He's going to keep buying it. I bet I can go through almost anybody's house and find something that they use that's probably not the best thing in the world to throw in a landfill. We have to start being honest with each other and recognize that we're all part of the problem.

The third goal of Amnesty Days, which is long range and probably the most important, is to reduce the public's anxiety about transfer stations. If we don't have some convenient place to collect this toxic material and ship it out of the state to Emelle, Alabama, it's going to go in the garbage cans, the trash cans, and the dumpsters and it will be hauled to where it could possible get into the waste stream. This is one of the major tremendous goals of Amnesty Days.

I want to move real quickly from Amnesty Days to resource recovery. We used to think about garbage as stuff that people fed to hogs. Egg shells, grapefruit rinds, scrambled eggs and all those kinds of innocuous things. We would dispose of those things, they would degrade and wouldn't cause much of a problem. However, in the last five years, we've had 45,000 new chemicals brought into our environment. That's not counting all the old ones. The technology is straining to keep up with all the new things that could be a problem when they're improperly disposed. That's the bottom line--improper disposal.

Today we have all kinds of things going into our waste stream. Forty-four percent of what's going in our waste stream is paper. Newspapers, magazines, cardboard boxes, yellow pads, governmental stuff. Forty-four percent of that stuff is going into the waste stream and it's filling it up. About 29 percent is glass, metal, and those kinds of hard substances. We don't know what the remaining 27 percent is. I think we're going to have to develop a system in Florida for addressing this problem. There isn't just one way to deal with this problem. Amnesty Days are not going to solve the hazardous waste problem. Landfills are not going to solve the problem.

When we had our very first hearing on the Water Quality Assurance Act in 1983, a very brilliant environmental engineer from the University of Florida testified that it is technologically possible to build a secured landfill on the top of the Biscayne Aquifer. There isn't anybody that wants to build a landfill, secure or otherwise, on top of the Biscayne Aquifer, but the technology is available. It wasn't too many years ago when everybody was using the buzz word "resource recovery" that we didn't have the technology to make it work. Today, we have the technology. DER is doing a good job keeping abreast of the technology that's available. I'm comfortable that the research they're doing is as good as we can get in Florida. The problem is that the legislature has lacked courage in the last three or four years to fund the programs that we've given DER to accomplish. Landfills are one of the problems we've asked DER to work on.

The other thing we're going to have to do at the state level is to address the seriousness of the infrastructure problem for local governments. Landfills will bring this into clear focus for the state legislature. Those of you that have been involved with local government over the past years know that we are bumping the revenue producing check every single day when we're trying to solve problems for our local governments and the services that our citizens need. Dixie County put a ten mil cap on their ad valorum taxes for two years. Not one employee in Dixie County has gotten a raise in two years. You can't keep people working for you for a long period of time without raises. Dixie County's jail is being closed down by the federal court system. They have a problem with their landfill and they don't have much of a tax base.

I think the state is going to have to face up to the responsibility of providing revenues for local government. One possibility is to repeal the sales tax exemptions. There's $1.5 billion of sales uncollected every year in Florida. I support education. We need to put as much money into education as we can, because an educated society is society that's much better able to deal with their problems. We don't have to run around worrying about the garbage hole. We can talk about technology. Education is not the only competitor for the dollars at the state level. Local government will be one of those groups that going to be in there fighting to get their share of the new resources.

Another thing we need to consider is a way to allow local government to do it for themselves. We have done too much mandating from the state without providing the revenues. At the same time, we have not allowed local government to do it for themselves. We jealously guard the sales tax. We won't allow local government to create any new, innovative taxing proposals or revenue generating proposals and I think we're going to address that this year in the legislature. I think it's something that we have to get done.

Finally, I promised myself that I wouldn't leave a group of enlightened citizens without going through this last little exercise. So, those of you that have been through it with me before I hope you'll bear with me.

I was in Minnesota giving a speech to the legislature and to their state hazardous waste management board which is trying to solve Minnesota's hazardous waste disposal problem. Minnesota is a very enlightened state and they've always been at the cutting edge of new environmental laws. The reason they called me out there was because they heard me give a speech about Amnesty Days at a national conference on hazardous waste. They thought maybe that the Amnesty Day program was something that could break the log jam. They had a big log jam in the entire State of Minnesota because they had started with their hazardous waste problem from the wrong end. They decided to site a facility first. The state was divided into four sections and one person from each section was appointed to this commission along with two or three other people. The commission was at a deadlock trying to to move the hazardous waste protection program forward because nobody could decide where to build this facility. They didn't know what kind of facility they needed to build, yet they were trying to figure out where to put it.

One of the things that I got out there was a poster. It was produced by the Minnesota Hazardous Waste Board. The poster is a three character Chinese word which means crisis. The Chinese are so wise and they have such wonderful messages in everything they do. When you use the first character of this word alone it means "danger." I think that's what we have in Florida right now. We have a crisis that's frought with danger. Everytime we open up another pit somewhere or inspect an underground storage tank there's danger. But the Chinese give us hope in this word "crisis." These last two characters when used alone mean "opportunity." I think that's what we have before us today. A conference of this type and the other things that we're doing in the state to address these problems is our opportunity. My message to you is that we need to seize this opportunity, eliminate this danger, and get rid of this crisis.

WHERE WILL OUR GARBAGE GO? THERE IS NO AWAY:
An International Conference on Waste Reduction, Reuse, and Disposal Alternatives

Strategies for the Comprehensive Management of
Domestic, Municipal, and Hazardous Wastes
February 28 - March 1, 1986
University of Florida
Gainesville, Florida

Outline of Remarks by

Kenneth A. Shuster, Chief
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* I like this conference:

1) Realistic premise: "THERE IS NO AWAY". Waste is a fact of life. Residuals always remain to be managed. The question is how best to manage it.
2) Comprehensive scope: First, what is the problem to be solved? Then, what are the alternative solutions and their pros and cons in both environmental and economic terms. I suspect that practicalities of implementation and equity considerations also enter the decision-making process. Hopefully, the result will be a better awareness of the issues and some ideas for action.

* I plan to follow the program agenda in my remarks. First, I'll discuss the problem. Then I'll discuss various solutions, from waste minimization, reduction, and recycling, to treatment and disposal. I'll discuss briefly some of the activities at EPA under the Resource Conservation and Recovery Act. I'll also ask some questions and tell some anecdotal stories to help set the stage for further discussions.

I. THE PROBLEM:

*Current major management methods: landfilling, incineration

A. Landfills (land disposal)
  *Ground water contamination
    -Well contamination
  *Surface water contamination
    -Fishkills
  *Subsurface gas migration
    -Asphyxiations
    -Explosions (methane)
  *Air pollution
  *Soils
B. Incineration (municipal waste combustion)

- *Air pollution
  - -E.g., dioxin controversy
- *Ash disposal
- *High capital costs

C. Recycling/reuse/source separation
- *Economics/convenience

D. Treatment technologies
- *Economics/demonstrated performance

E. New facility siting (capacity)

F. Regulations/enforcement

II. THE SOLUTION:
- *Need a comprehensive approach, using a wide range of technologies
- *Primary goal:
  - -Protection of human health and the environment
- *Secondary goal:
  - -Resource conservation and recovery

A. Elements of a comprehensive approach:
- *Technology research and development/demonstrations
- *Technical assistance/educational programs (training, technical guidances)
- *Economic incentives (bonds, taxes/fees; environmental costs built in)
- *Regulations/enforcement

B. Technologies
- *Waste minimization
- *Recycling/reuse: materials recovery; energy recovery
  - -Source separation recycling
    - -Households
      - -Newspapers, corrugated, other paper (30-50% of waste)
      - -Aluminum, steel, lead, other metals (10% of waste)
        - -5% Al cans in U.S. are recycled
      - -Glass: for glasphalt or cullet (10% of waste)
      - -Leaves (10-20% of waste)
        - -Composting (e.g., Arlington, Va.)
      - -Used oil
      - -HHW
    - -Offices, businesses
      - -Paper
    - -Waste exchanges
    - -Waste-as-fuel
  - -Mixed waste recycling
    - -Shredding
      - -Air separation: materials; organic fuel
    - -Materials recovery
    - -Composting
      - -Problem with composting has been marketing (e.g., St. Petersburg story)
- *Treatment
  - -Incineration (municipal waste combustion/energy recovery)
    - -WASTE AGE--Jan, 1985:
      - -58 MW energy recovery incinerators operating in

U.S. (6 in FL)
    - -33 more being developed (5 in shakedown phase)
- -Shredding
- -Baling
- -Solidification
- -Encapsulation
- -Biological
    - -Tanks, land treatment, surface impoundments

*"Sanitary Landfill" disposal
- -Location
    - -Ground water/land use planning
    - -TOT vs depth to water table
- -Waste restrictions
    - -Solveents
    - -Used or waste oil
    - -HHW--is it a problem?
    - -SQG waste--is it a problem?
    - -Leaves; other yard waste
    - -Liquids in drums
    - -Bulky items
- -Technologies
    - -Waste treatment: neutralization, degradation, transformation, destruction, solidification/fixation
    - -Encapsulation
        - -Major treatment for rad waste
    - -Liners, LCRS, covers, post-closure care
        - -Stories about HW facility liners (QA/QC): plugged perf. pipe; plugged LCRS; large unseamed gaps
    - -Monitoring and corrective action
    - -Run-on/run-off controls (surface water0
    - -Methane gas recovery and control (subsurface gas)

C. Liability/responsible parties

*Generator, transporter, treater, disposer
*CCHW landfill aquisition recommendation
*HHW issue

III. EPA ACTIVITIES-- What has EPA been doing toward solutions?

*Most current activities are in response to 1984 HSWA
*HSWA made major changes to HW (Subtitle C) and non-haz. waste (Subtile D) programs

A. Hazardous waste activities (40 CFR 260-266; 270-1)

*HSWA uses new Congressional approach--hammers (e.g., SI liner retrofit, land disposal waste restrictions)
*HSWA seeks to close loopholes in regulations (e.g., air standards; location standards)
*HSWA emphasizes move away from land disposal
*Examples of significant changes:
- -Tighter control over wastes
    - -Waste listings/delistings--stricter criteria
    - -SQG exemption lowered (from 1000 to 100 kg/mo)
    - -Used oil control
- -Stricter standards for land disposal
    - -Land disposal restricions

- -Retrofitting SIs
- -Liners/LCRS (min tech requirement)
- -Corrective action for prior releases
- -Permits
    - -Mandatory timetable for LD permits
    - -Exposure assessments

-Waste minimization

- -Generator must certify that waste volume and toxicity have been reduced to max amt practical

-Treatment technologies promoted

- -LD Restrictions tied to treatment
- -Burning and blending rules
- -Municipal waste burning at resource recovery facilities exempt from Subt. C if o/o takes certain precautions

B. Non-hazardous waste activities

*Again, primarily tied to HSWA

*Pre-HSWA:

- -Existing Criteria--40 CFR 257
    - -Issued in Sept., 1979
    - -Implemented by States and citizen suits; no EPA enforcement authority
    - -General environmental performance stds, for most part
    - -Implementation guidance manual issued by EPA
    - -Major provisions:
        - -Floodplains
        - -Endangered species
        - -Surface water
        - -Ground water
        - -Food chain crops
        - -Disease
        - -Air
        - -Safety: explosive gas, access, fires, bird hazards to aircraft

*HSWA provisions

- -EPA must:
    - -Conduct a Subtitle D study to determine if the current Criteria are adequate to protect human health and the environment from ground-water contamination, and submit a report to Congress by November 1987 on the results of the study (see study info below)
    - -Revise the Criteria by March 31, 1988, for facilities that may receive hazardous household waste or small quantity generator hazardous waste (see Criteria revision info below)
    - -Complete studies on methods for extending landfill life and reusing landfilled areas, and submit first report to Congress by October 1, 1986
- -States must:
    - -Have a permit program for the existing Criteria by Nov. 1987
    - -Have a revised permit program 18 months after the revised Criteria are issued

- -EPA may enforce the Criteria if a State fails to do so
- *EPA Subtitle D Study
  - -Objectives:
    - -Evaluate environmental impacts of all Subtitle D facilities
    - -Evaluate control technologies
    - -Evaluate State Subtitle D programs
    - -Determine adequacy of Subtitle D Criteria
  - -Two study phases:
    - -Phase I--Evaluation of readily available data
    - -Phase II--Collection and evaluation of new data, including site-specific data; and development of report to Congress
- *Subtitle D Criteria revisions
  - -Schedule:
    - -Proposal--March, 1987
    - -Final --March, 1988
  - -Likely content:
    - -RCRA amendments mandate at least:
      - -Ground water monitoring
      - -Corrective action, as appropriate
      - -Location restrictions
    - -Other provisions, such as liners, waste restrictions, and landfill gas controls, will be considered
- *Conferences/EPA meetings:
  - -Public meeting on Subtitle D Criteria reg. options--Jun or Jul, 1986
  - -Public meeting on Subtitle D study & Criteria and HHW--Nov 19-21, 1986
  - -Both in Wash, D.C. area

C. Number of facilities

	Number of Units		
	Subtitle D		Subt C
Type of Unit	* (1984)	Total (1979)	(1985)
Landfills (total)	22,000	94,200	301
Municipal waste	18,500	18,500	---
Industrial waste	3,500	75,700	---
Surface impoundments	17,700-36,300	181,000	953
Land Treatment	?	?	148
TOTAL	39,700-58,300	275,200	1,402

*Rough estimate of units that may receive hazardous household wastes and SQG hazardous waste (<100 kg/mo); based on 1984/85 SQG survey

D. Characteristics of municipal waste leachate
  *See attached tables
E. Underground storage tanks--Subtitle I
F. CERCLA
  *RCRA regulates active and new facilities
  *CERCLA applies to inactive/past practices

IV. RESULTS

*Better protection of human health and the environment
*More resource conservation and recovery
*More regulation and enforcement
*Higher costs
*More care and time spent in managing waste (from generator to disposer)
  - Corporate environmental audits
  - Site access controls

Typical Listing of Hazardous Household Waste

- Pesticides, insecticides, rodenticides, herbicides (malathion, chlordane, DDT, arsenic, Weed-B-Gon), disinfectants
- Fertilizers
- Swimming pool chemicals
- Wood preservatives
- Stains, varnishes, paints, solvents, thinners, paint removers
- Degreasers, spot removers, drain cleaners, oven cleaners, detergents
- Unused flammable liquids (gasoline, kerosene)
- Battery fluids, batteries
- Photographic chemicals
- Chemistry sets
- Radiator fluids and additives, transmission additives
- Fingernail polish remover

Table 1

Concentration Ranges for Components of Landfill Leachate

Parameter (in mg/l except when noted otherwise)	Concentration Range*	"Typical" Concentration Range**
BOD_5	4 - 57,700	1,000 - 30,000
COD	31 - 89,520	1,000 - 50,000
TOC	0 - 28,500	700 - 10,000
Total volatile acids (as acetic acid)	70 - 27,700	--
BOD_5/COD (ratio)	0.02 - 0.87	0.6 - 0.8
COD/TOC (ratio)	0.4 - 4.8	1 - 4
Total Kjeldahl nitrogen (as N)	7 - 1,970	10 - 500
Nitrate (as N)	0 - 51	0.1 - 10
Ammonia (as N)	0 - 1,966	--
Total phosphates	0.2 - 130	0.5 - 50
Orthophosphates	0.2 - 130	--
Total alkalinity (as $CaCO_3$)	0 - 20,850	500 - 10,000
Total hardness (as $CaCO_3$)	0 - 22,800	500 - 10,000.
Total solids	0 - 59,200	3,000 - 50,000
Total dissolved solids	584 - 44,900	1,000 - 20,000
Specific conductance (umhos/cm)	1,400 - 17,100	2,000 - 8,000
pH (units)	3.7 - 8.8	5 - 7.5
Calcium	60 - 7,200	100 - 3,000
Magnesium	17 - 15,600	30 - 500
Sodium	0 - 7,700	200 - 1500
Chloride	4.7 - 4,816	100 - 2,000
Sulfate	10 - 3,240	10 - 1,000
Chromium (total)	0.02 - 18	0.05 - 1
Cadmium	0.03 - 17	0.001 - 0.1
Copper	0.005 - 9.9	0.02 - 1
Lead	0.001 - 2.0	0.1 - 1
Nickel	0.02 - 79	0.1 - 1
Iron	4.0 - 2,820	10 - 1,000
Zinc	0.06 - 370	0.5 - 30
Methane gas (percent composition)	(up to 60%)	--
Carbon dioxide (percent composition)	(up to 40%)	--

-- Indicates no data presented by cited author.

*Based on data of Pohland [2], Pohland and Harper [3], Keenen et al. [4], Chian and DeWalle [5], and Mikucki et al. [6].

**Ranges in which 70% of the literature values reported by Lu et al. [7] fall.

After: Lee et al. [1]

Formation, Characteristics, Treatment and Disposal of Leachate from Municipal Solid Waste Landfills

By
Paul M. McGinley
Peter Kmet

A Wisconsin Department of Natural Resources
Special Report

August 1, 1984

Bureau of
Solid Waste
Management
DAILY NE
RECY

3.5 Trace Organics

The primary organic compounds in landfilled municipal waste and their subsequent appearance in landfill leachate were examined in a general way in the oxygen demand section. While the oxygen demand gives an indication of the overall organic concentration, it fails to identify individual organic compounds. Analysis of leachates by several researchers has led to some general characterizations of the leachate organic matter. Khare and Dondero (1977), and Burrows and Row (1975) found that many of the organics in leachate are those normally associated with anaerobic decomposition, such as organic acids and alcohols. Although deleterious effects can be evidenced upon discharge of these compounds to the environment, the assimilation of these compounds naturally is well documented.

In addition to the organic compounds associated with the biological decomposition of waste, there can also be numerous trace organic compounds of synthetic origin in leachate. These chemicals, of which there are hundreds of thousands, can sometimes be found naturally, but are largely associated with the increase in organic chemical manufacturing in the last fifty years. These man-made organics, generally found at trace concentrations, are of concern because of their possible toxic, carcinogenic or mutagenic properties, and their occasional persistence in the environment.

The presence of these trace organic compounds in leachate can be attributed to a variety of wastes. Direct deposition of these compounds in the landfill or their inclusion as a contaminant in a deposited industrial waste are the most obvious sources. Additionally, because many synthetic organic compounds are used in manufacturing processes, the decomposition of municipal and commercial refuse can lead to their release. Many household and commercial products can contain trace quantities of organic materials. Examples include: phenols in pharmaceuticals, dinitrophenols in toilet deodorant blocks, and methylene chloride in aerosol sprays.

Analyzing the organic chemicals present in leachates would be a staggering task due to the great number of possible compounds. One framework for the evaluation of trace organic contaminants in leachate is the list of EPA Priority Pollutants. These are compounds which have been selected from the 1977 Clean Water Act's Toxic Pollutant List. The Toxic Pollutants were compounds or groups of compounds which were shown to be either carcinogenic, mutanogenic, tetragenic, or they were known to have toxic effects on humans or aquatic organisms. The 114 organic compounds which the Priority Pollutant list contains were selected from the Toxic Pollutants on the basis of their frequency of occurrence, standard availability and production history.

Leachate samples from nine Wisconsin landfills have been analyzed for priority pollutant organic compounds. Eight of these sites: 11, 572, 1099, 1678, 2568, 2569, 2822, and 2895, have complete organic analysis and site 611 has examined three of these compounds. In Table 3.12, all of the priority pollutant organics are listed which have been detected in Wisconsin leachates. The analysis results for these sites and their frequency of detection in leachates from other states is also shown.

Table 3.12 Priority Pollutant Organic Compounds Detected in Wisconsin Leachates and the Results of those Analyses.

concentrations in parts per billion(micrograms per liter)

Compound																									Wisconsin Leachates Summary		Other States Leachates					
Site ID	11	11	572	611	1099	1099	1099	1678	1678	1678	1678	1678	1678	1678	1678	2568	2569	2822	2895	2895	2895	2895	2895	2895			OR	CO	MN	OK	OC	MI
Sample Source	CS(M3)	CS(M3)	CS(M)	CS	CS	LS(M1A)	CS(R2)	CS	CS(R2)	CS(R5)	CS(M1)	CS(H2)	CS(M1)	CS(R5)	CS(H6)	LS	CS	CS	CS	CS(R3)	CS(T)	CS(R3)	MW(68)	MW(77)								
Sampling Date	Mar-82	Oct-82	Jan-81	Dec-80	Dec-80	Apr-82	Apr-82	Dec-80	Mar-82	Mar-82	Apr-82	Oct-82	Oct-82	Oct-82	Oct-82	Mar-84	Mar-84	Nov-81	Dec-80	Apr-82	Apr-82	Feb-84	Feb-84	Feb-84	Max Conc (ug/l)	% Det	(1)	(2)	(3)	(4)	(5)	(6)
Halogenated Ethers																																
2-Chloroethyl Vinyl Ether	<10	<10	<10		<320	<10	<10	<400	2	1100	<10	<10	<10	<10	<10	<1	<1	<100	<320	<10	<10	<10	<10	<500	1100	9%					X	
Bis(2-chloroethoxy)methane	<10	<10	<10		<100	<10	25	<50	<10	<10	<10	<10	<10	<10	<10	<1	<1	<10	<100	<10	18	<10	<10	<10	25	9%						
Bis(Chloromethyl)Ether	<10	<10	250		<500	<10	<10	<500	<10	<10	<10	<10	<10	<10	<10	<1	<1		<500	<10	<10				250	5%						
Halogenated Aliphatics																																
Methylene Chloride	<10	<10	2300	106	20000	450	<10	2800	1500	430	4900	835	1520	7	1480	540	780	2500	1100	1900	<10	92	<10	2800	20000	79%	200	200	1300			X
1,2-Trans-Dichloroethylene	<10	24	1300		<250	<10	<10	2200	1300	<10	<10	1520	86	168	2760	17	55		96	<10	<10	26	<10	1400	2760	53%	44	62	88			
1,1-Dichloroethane	<10	<10	6300		<250	<10	5	510	<10	64	<10	419	264	134	720	110	61	570	<250	160	<10	<10	<10	1900	6300	57%	10	194	46		X	X
Trichloroethylene	<10	<10	160		<250	<10	<10	800	370	<10	43	542	56	16	1120	33	28	<100	<250	180	<10	<10	<10	<500	1120	48%		53			X	X
Tetrachloroethylene	<10	<10	26		<250	<10	<10	60	<10	<10	215	141	232	2	620	11	25	<100	<250	<10	<10	<10	<10	<500	620	39%		162			X	X
1,1,1-Trichloroethane	<10	<10	2400		<250	<10	<10	<250	<10	<10	840	84	196	<10	310	16	18	<100	<250	<10	<10	<10	<10	<500	2400	30%	20	227	7.8			
1,2-Dichloropropane	<10	<10	54		<250	<10	<10	<250	<10	<10	<10	2	4	86	50	5	3	<100	<250	<10	<10	<10	<10	<500	86	30%			81			
Chloroethane	<10	<10	170		<250	<10	<10	<250	860	<10	<10	<10	<10	<10	27	16	20		<250	<10	<10	<10	<10	400	860	27%		18	0			
Trichlorofluoromethane	<10	<10	15		<250	74	<10	<250	<10	<10	<10	54	110	<10	<10	6	11	<100	<250	<10	<10	<10	<10	<500	110	26%	8	78	15			X
Chloroform	<10	<10	71	14.9	<250	<10	<10	<250	<10	<10	<10	<10	8	<10	<10	27	31	1300	<250	<10	<10	<10	<10	<500	1300	25%	17	0			X	X
1,1,2-Trichloroethane	<10	<10	<10		<250	<10	<10	<250	<10	<10	<10	352	30	<10	<10	<1	<1	500	<250	<10	<10	<10	<10	<500	500	13%			125			X
1,2-Dichloroethane	<10	<10	13		<250	<10	<10	<250	<10	<10	<10	<10	<10	<10	<10	1	<1	11000	<250	<10	<10	<10	<10	<500	11000	13%			5.5			X
Dichlorodifluoromethane	<10	<10	180		<250	<10	<10	<250	450	<10	<10	<10	<10	<10	<10	<1	<1	<100	<250	<10	<10				450	10%		65	0			
1,3-Dichloropropylene	<10	<10	18		<250	<10	<10	<250	<10	<10	<10	<10	<10	<10	30	<1	<1	<100	<250	<10	<10	<10	<10	<500	30	9%		0				
Vinyl Chloride	<10	<10	61		<250	<10	<10	<250	<10	<10	<10	<10	<10	<10	47	<1	<1	<100	<250	<10	<10	<10	<10	<500	61	9%		14	0			X
1,1,2,2-Tetrachloroethane	<10	<10	<10		<250	<10	<10	<250	<10	<10	<10	<10	<10	<10	<10	<1	<1	210	<250	<10	<10	<10	<10	<500	210	4%		0	250			X
Methyl Bromide	<10	<10	170		<250	<10	<10	<250	<10	<10	<10	<10	<10	<10	<10	<1	<1	<100	<250	<10	<10	<10	<10	<500	170	4%			0			
Methyl Chloride	<10	<10	170		<250	<10	<10	<250	<10	<10	<10	<10	<10	<10	<10	<1	<1	<100	<250	<10	<10	<10	<10	<500	170	4%			0			
Monocyclic Aromatics																																
Toluene	190	460	1600		290	8	<10	1400	1900	<10	1740	700	419	790	1430	56	79	200	420	720	390	420	29	3200	3200	91%	1500	20	600		X	X
Benzene	270	67	19		<250	310	470	<250	800	580	1080	120	9	46	100	4	4	<100	<250	440	380	18	<10	<500	1080	74%	28	11	540		X	X
Ethylbenzene	<10	245	250		<250	<10	<10	150	500	<10	<10	890	38	238	1270	8	7	140	<250	<10	<10	67	4800	<500	4800	57%	52	0	820			X
Isophorone	<10	<10	<10		4000	4	<10	16000	500	210	160	224	78	<10	524	<50	<50	<10	<250	<10	180	15	<10	<10	16000	48%						
1,4-Dichlorobenzene	8	<10	<10		<100	<10	37	<20	<10	<10	<10	5	4	4	8	<50	<50	<20	<100	<10	1	<10	<10	<10	37	30%	8		16			X
Chlorobenzene	<10	4	<10		<250	<10	<10	<250	<10	<10	<10	5	3	1	7	<50	<50	<100	<250	<10	<10	<10	<10	<500	7	22%	20		80			X
1,2-Dichlorobenzene	<10	<10	<10		<100	<10	<10	<20	13	<10	<10	9	<10	<10	9	<50	<50	<20	<100	<10	<10	<10	<10	<10	13	13%			32			X
Nitrobenzene	<10	<10	40		<100	<10	<10	120	<10	<10	<10	<10	<10	<10	<10	<50	<50	<20	<100	<10	<10	<10	<10	<10	120	9%						

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Table 3.12 continued

concentrations in parts per billion(micrograms per liter)

Compound	Site ID 11 CS(M3) Mar-82	11 CS(M3) Oct-82	572 CS(M) Jan-81	811 CS Dec-80	1099 CS Dec-80	1099 CS(M1A) Apr-82	1099 CS(R2) Apr-82	1678 CS Dec-80	1678 CS(R2) Mar-82	1678 CS(R5) Mar-82	1678 CS(M1) Apr-82	1678 CS(R2) Oct-82	1678 CS(M1) Oct-82	1678 CS(R5) Oct-82	1678 CS(R6) Oct-82	2568 CS Mar-84	2569 CS Mar-84	2822 CS Nov-81	2895 CS Dec-83	2895 CS(R3) Apr-82	2895 CS(1) Apr-82	2895 CS(R3) Feb-84	2895 HW(68) Feb-84	2895 HW(77) Feb-84	Wisconsin Leachates Summary Max Conc (ug/l)	Wisconsin Leachates Summary % Det	Other States Leachates OR (1)	CO (2)	MN (3)	OK (4)	DE (5)	MI (6)
Polycyclic Aromatics																																
Naphthalene	13	<10	19		<100	<10	<10	<50	<10	8	<10	41	<10	<10	68	<50	<50	<10	<100	2	10	<10	<10	<10	68	30%						X
2-Chloronaphthalene	<10	<10	<10		<100	<10	<10	<20	<10	<10	<10	<10	<10	<10	46	<50	<50	<10	<100	<10	<10	<10	<10	<10	46	4%						
Phenols																																
Phenol	<25	19	221		<25	13	<25	5790	3700	1230	1800	11300	1080	51	11050	500	110	<10	293	39	350	<25	<25	<2500	11300	70%	2300	272000				X
Pentachlorophenol	<25	<25	<25	3	<25	<25	<25	<75	<25	<25	<25	<25	<25	<25	<25	<50	<50	<10	<25	<25	<25	45	470	<2500	470	13%						
2,4-Dimethylphenol	<25	<25	<25		<25	<25	<25	<75	10	<25	<25	<25	<25	<25	<25	<50	<50	<10	<25	<25	<25	<25	28	<2500	28	9%		D				X
4-Nitrophenol	<25	<25	<25		<25	<25	<25	<75	<25	<25	<25	<25	<25	<25	<25	<50	<50	17	<25	<25	<25	<25	<25	<2500	17	4%						
Phthalate Esters																																
Diethyl Phthalate	<10	<10	43		200	71	3	300	300	170	330	254	<10	<10	107	69	<50	<20	150	28	82	<10	11	120	330	70%		12		X		
Bis(2-ethylhexyl)Phthalate	<10	<10	34		150	<10	<10	50	<10	<10	<10	<10	<10	<10	<10	<50	<50	110	150	<10	<10	<10	32	<10	150	26%		12			X	
Di-N-Butyl Phthalate	<10	<10	12		100	<10	<10	<20	<10	<10	49	<10	<10	<10	<10	<50	<50	<10	150	<10	<10	<10	<10	<10	150	17%		D		X	X	
Butyl Benzyl Phthalate	<10	<10	<10		125	<10	<10	<20	<10	<10	21	<10	<10	<10	<10	<50	<50	<50	150	<10	<10	<10	<10	<10	150	13%		D		X		
Dimethyl Phthalate	<10	<10	55		<100	<10	<10	30	<10	<10	<10	<10	<10	<10	<10	<50	<50	<20	<100	<10	<10	<10	<10	<10	55	9%						
Miscellanious																																
Acrolein	<100	<100	<10		<1500	<100	<100	<1500	<100	<100	<100	<100	<100	<100	<103	<10	<10	<10	270	<100	<100	<100	<100	<5000	270	4%		D				

Sources:

(1): Spencer, 1984. Maximum concentration in leachates from three Oregon landfills
(2): Shuckrow et al., 1982. Maximum concentration from leachate seep at Marshall Landfill, Boulder Colorado
(3): Sabel and Clark, 1983. Maximum concentration in leachates from six Minnesota landfills
(4): Robertson et al., 1974. Compounds detected in groundwater beneath the Norman landfill in Oklahoma
(5): DeWalle and Chian, 1981. Compounds detected in leachate from the Army Creek landfill in Delaware
(6): Shuckrow et al., 1982. Compound detected in groundwater near the Ott/Story landfill in Michigan

Notes:

All concentrations in parts-per-billion(micrograms per liter)
CS indicates sample from leachate collection system
HW indicates sample from leachate headwell
D denotes compound detected at concentration below detection limit
X denotes compound detected above detection limit

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From Table 3.12 it is apparent that approximately one half of the priority pollutant organic compounds have been detected in leachates and wastewaters. These organics are generally the volatile solvents, aromatic solvents, phenols and pthalate esters. Significantly, few of the polycyclic aromatic hydrocarbons and none of the nitrosamines have been detected. Pesticides and PCB's are also not commonly detected in landfill leachates in Wisconsin.

In addition to the priority pollutant list, other trace organic compounds have been found in leachates from land disposal sites. Where appropriate, these compounds will be included in the analysis.

Within each of the major classes of organic compounds the physical properties and nature of the toxicities can be similar. The results of the organic analyses have been divided into major classes reflecting these similarities. These groups are:

- Halogenated ethers and aliphatics
- Phthalate Esters
- Phenols
- Monocyclic and Polycyclic aromatics
- Polychlorinated biphenyls
- Pesticides and herbicides

The emphasis in these sections will be on those chemicals which have been detected in leachates from Wisconsin landfills. Those concentrations will be compared to other leachates, water quality criteria and concentrations inhibitory to biological treatment processes.

Halogenated Ethers and Aliphatics

Thirty-three of the organic compounds on the priority pollutant list are chlorinated or brominated ethers and short chain hydrocarbons. Twenty-one of these compounds have been identified in the leachates from Wisconsin landfills. These compounds are common industrial chemicals and are used in a variety of manufacturing processes. Some of their uses include: refrigerants, propellants, solvents and cleaners. Most of these compounds are volatile, persistent and non-accumulative (Chapman et al., 1982), and many are carcinogenic. Table 3.13 lists these compounds, their inhibitory concentrations and their ambient water quality criteria.

Methylene chloride was the most commonly identified of these compounds, detected in 19 of 24 leachate samples. Although natural sources of it have been proposed, it is probably its use as an industrial solvent and in paint removers, aerosol sprays, and insecticides that lead to its appearance in the environment (U.S. EPA, 1980). Methylene chloride is also a common laboratory solvent so that its detection may also result from laboratory contamination during analysis.

SOLID WASTE TECHNOLOGY AND ITS IMPACT UPON[1,2] LOCAL LAND USE AND LAND VALUES

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I. INTRODUCTION

A. BACKGROUND TO THE SOLID WASTE PROBLEM

The collection and disposal of household solid waste are considered by Americans to be a basic responsibility of municipal government. General household solid waste, or refuse, is composed of: paper from packaging and newsprint; glass, metal and plastics from containers; wood, leather and rubber; yard debris, sand and ash; and organic kitchen refuse (garbage) (for more detail, see Hocking, 1975). Beyond placing the refuse at curbside for collection, most households do not question what happens to their refuse. Instead, the question of what to do with household solid waste must be answered every day of the year by the municipality. Unlike the disposal of hazardous waste, the disposal of household solid waste has received little attention from academic researchers, the news media and the general public.

The following are examples of the nonhazardous solid waste problem: Jacksonville (population 629,084) and Madison, Wisconsin (population 170,000). Each business day, Jacksonville must dispose of solid waste equal to 27 times the volume of its Gator Bowl Football Stadium. Madison is faced with the problem of disposing of 250 tons of refuse per day, five days per week. The per capita production of household solid waste at present increases by about 1% per year; to exacerbate the problem, the

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[1] This paper is based upon a presentation by the author at the interdisciplinary conference on waste reduction, reuse, and disposal alternatives, University of Florida School of Law; 28 February 1986. Excerpts were released in an Associated Press article and published in Gainesville Sun, 29 February 1986, p. 16A, and 27 other newspapers in Florida, with the title "Waste disposal method may determine future growth of city".

[2] I would like to thank Professor Anthony LaGreca and his staff in the Urban and Regional Research Center, University of Florida, for comments and assistance in the literature review.

population of these two cities is increasing by between 2% and 6% each year. (For a general discussion see B.J.L. Berry et al. (1974, p. 344).) This is why most states now consider the construction of environmentally sound solid waste sites as a top priority (Florida Department of Environmental Regulation, 1981, p. VIII-19).

From the earliest times, the technology typically deployed for the disposal of solid waste has been merely to place the refuse in a pile, namely open dumping (Stone, 1978). Refuse dumps were usually placed away from major concentrations of the population; however, the farther removed was the dump, the greater the transportation cost of accessing the dump. Moreover, those people who lived near the dump site found them objectionable not only because of rodents but also because of their unsightliness and odors, often made worse by open burning.

The first experimental centrally controlled incinerator dates to 1874, England. These incinerators were expensive to operate and produced widespread noxious odors. In Fresno, California, during the 1930s, experimentation was done with what is now known as "sanitary land fill" technology: five to twenty foot layers of solid waste alternate with one to two feet of clean soil (Stone, 1978).

Large scale biochemical composting dates from the early 1960s. This method of solid waste disposal can be made economically competitive by revenues from the sale of the humas and methane end product. Composting is used for the production of refuse derived fuel (**RDF**) which can be used in incinerators to produce steam to power turbines that generate electricity. American cities began to adopt new solid waste disposal technology in the 1970s; the technology has not however become as diffuse in the United States as it has in Europe. Over one-hundred incineration plants using **RDF** from composting are presently operational in France, producing over 800,000 tons per year of compost. Over 700,000 tons of compost are produced in Germany each year; one-fourth of Sweden's solid waste is now composted into **RDF**.

The problem of household solid waste disposal was first addressed at the national level with the 1965 Solid Waste Disposal Act which authorized grants to develop comprehensive plans for the municipal solid waste problem. These studies led to the 1976 Resource and Conservation and Recovery Act which prohibited open dumping and also provided for a separate body of laws to regulate the disposal of hazardous waste. Municipalities have been actively exploring and occasionally adopting new technologies of solid waste disposal because of these acts (Title II of Public Law 89-272, and Public Law 94-580). A real problem that each community must contend with is how to dispose of the growing mountain of refuse. This problem is complemented by communities' fear of awaking to a Love Canal in their own backyard. The new technologies being adopted are actually variations of the earlier burial and composting technologies, coupled with incineration.

B. DESCRIPTION OF CONTEMPORARY SOLID WASTE TECHNOLOGY

1. SANITARY LAND FILLS

The sanitary landfill acts, in theory, as a box containing refuse. The United States Environmental Protection Agency (**EPA**) now regulates such land fills. Regulation extends to the maintenance of active sanitary landfills, as well as maintenance of the land fill for at least twenty years following its closure. There are several classifications of sanitary landfills, but their construction generally includes a base liner such as reinforced nylon fiber liners (Johnson, 1981). When a landfill is closed, the **EPA** requires the installation of a containment cap, along with wells to permit the collection of methane and the removal of liquid from the bottom of the land fill. The liquid comes from household, commercial and industrial wastes, and as a byproduct of vegetative decay.

In practice, however, liquid waste can escape the sanitary landfill box. Heavy concentrations of certain wastes disposed of by households can destroy parts of the base lining that subsequently permit diffusion into the surrounding soil and ground water. If a land fill is not closely monitored, illegal dumping of hazardous materials can occur; these hazardous materials can often destroy the base lining. Furthermore, the linings in solid waste burial sites may have been improperly installed. Also, a noninsignificant side effect of a solid waste land fill is that the odor, dust and noise from an active sanitary landfill decreases the desirability of the surrounding land particularly for residential purposes.

2. Incineration

The **EPA** also regulates the operation of solid waste incineration facilities. A desirable byproduct of such facilities is electric power. In a modern incineration facility, one ton of household solid waste has a gross heat value of about 0.45 tons of coal or 0.25 tons of fuel oil; this heat can be used to produce electricity. Often before heating, metal is separated from the refuse and sold as scrap.

To eliminate odors, flue gasses must pass through a zone of heat of about 800°C. The hot gasses generally are cooled to about 300°C and cleaned before being expelled into the atmosphere. However the process of cooling and cleaning reduces the potential turbine generated electricity (Holmes, 1981; p. 37). See Holmes (1981, pages 95, 99, and 101) for a discussion of the several competing incineration technologies that have been marketed by various manufacturers during the past decade.

Earlier technologies used in incineration had problems with air emissions and residual ash. In Helsinki, Finland (Kukkonen and Raunemaa, 1984) a solid waste refuse incinerator functioned for twenty years between 1963 and 1983; it was closed in 1983 because of high emissions, particularly of heavy metals. Samples of vegetation surrounding the facility indicated a very slight decrease in particulate matter pollution with increasing distance from the site. In Tehran, Iran (Chokouhmand, 1981) the incinerator produced nearly the same amount of total carbon monoxide (CO) as produced by all trucks, industrial and domestic sources in Tehran combined; it also produced approximately 50% of the total particulate matter emitted into the atmosphere by all other sources combined. Hence, the incinerator represented one of the single major facilities responsible for air pollution in Tehran.

Some support for the environmental difficulties experienced in Finland and Iran is found in work by Campbell (1976). While sulpher in refuse-derived fuel is approximately one-tenth the amount found in coal from the Eastern United States, the chloride content of refuse is significantly greater than that of coal. Of particular concern is the emission of metal chlorides (also cadmium, copper, lead and zinc) that are found in significant concentrations in the particulate matter of municipal incinerators.

In a study by Brown, Vence and Reilly (1981), emissions from modern incinerators were cited as continuing to be a problem. They found significant amounts of sulfur oxides (SO_x), nitrogen oxides (NO_x), hydrochloric acid (HCL), carbon monoxide (CO), and various trace elements. Emission rates from waterwall incinerators equal between 15 and 24 pounds of particulates per ton of refuse fired. In California, NO_x is now considered one of the more significant of common pollutants; this is exacerbated by the limited available controls presently available for reducing NO_x. Other effects are ambiguous; the Brown, Vence, and Reilly study quote the **EPA** as documenting a coal plus refuse derived fuel plant in St. Louis as producing potentially hazardous substances such as beryllium, cadmium, mercury, copper and lead in higher concentrations than would be found from coal only combustion; the **EPA** is also quoted as documenting just the opposite effect in a similar plant in Ames, Iowa. This suggests emissions depend upon the maintenance and management of an operational plant.

A subsequent case study by Brown, Vence & Associates (1983) commissioned by the State of California, summarized the history, benefits and problems of four communities that adopted solid waste incineration facilities: Auburn, Maine (population 24,000; 175 tons of solid waste burned per day); Saugus, Massachusetts (population 750,000; 1,170 tons of solid waste burnt per day); Akron, Ohio (population 275,000; 4,000 tons of solid waste burnt per day); and Madison, Wisconsin (population 170,000; 250 tons of solid waste burnt per day). The major concerns to the California Solid Waste Management Board were the control of air pollution, the management of ash residue, possible citizen opposition, and financing. The study reported no significant general population opposition to the development of the incineration facility in any of the towns investigated. Rather, the study of Saugus, Massachusetts, revealed citizen demand to replace the existing land fill, which was thought to be polluting the nearby marshland. Typically, initial opening of the incineration facilities caused complaints of the emission of odors and particulate matter; shortly thereafter, adjustments and improvements were made, and then the complaints stopped. This provides further evidence that management and maintenance can be a critical factor in the facilities effect upon the surrounding landscape. All case study sites reported a problem with safe ash disposal.

The residual from incinerating solid waste can be as much as 20% of the initial amount of solid waste. The ash usually has high concentrations of heavy metals; the officials of the waste sites considered it to be prohibitively expensive to treat the ash residue in the same manner as hazardous waste; hence, it is being deposited in regular land fills. Most federal and state laws would require waste with the composition of incinerator ash to be treated and disposed of as hazardous materials; however, doing so would raise the cost of using incinerator technology to a level as to make it non competitive with solid waste landfills. Therefore, most state laws and EPA regulations exempt incinerator ash from being defined as hazardous waste to enable that ash to be more cheaply disposed of with nonhazardous waste in regular household solid waste landfills.

Many communities are considering requiring households to reduce the volume of materials to be buried or to be incinerated by way of recycling. Recycling does not eliminate the need to bury or to incinerate, though it does reduce the volume of solid waste per household that need be disposed of. Typically, the revenues from recycling projects are insufficient to support their operations and thus must be subsidized if they are to be effectively implemented (OECD, 1981).

II. RELATED GEOGRAPHY LITERATURE

It is worthwhile to briefly review the general approach taken by geography researchers dealing with similar problems. The established method of viewing a problem such as the effect of a solid waste burial site upon local land use comes from the literature focusing upon externalities.

> **DEFINITION OF AN EXTERNALITY:** An externality is a spillover of the activity or environment at one site onto another site. The spillover is generally most intense immediately adjacent to the source, and decreases with distance from the source.

Because of the view, the benefits of a neighbor's flower garden spill over to the adjacent yard, as does access to favorable facilities such as parks. Such externalities are considered positive since they increase the welfare of the person receiving the externality.

Externalities can also be negative; they can reduce the welfare of households. Examples of negative externalities include noise from heavy traffic or industry, and odor and smoke such as that from industry. Love Canal is a well known example of a site that spread negative externalities to surrounding properties, thereby affecting nearby quality of life and land values.

1. Externalities and Land Values

In the geographic literature, the Consumption Theory of Land Rent of Thrall (1980) introduced a geometry that allows for the derivation of land use and land rent in terms of the access of a site to nodes of shopping and employment. These foundations have been subsequently extended to include the effect of a variety of parameters upon urban land values such as transportation cost (Thrall, 1982), city planning (Thrall, 1983), and externalities (Thrall, 1982). In brief, positive externalities generally increase housing land values while negative externalities generally decrease housing land values in proportion to the density of the externality. Externalities are usually of greatest density at that location where the externality originates, and generally decrease with increasing distance from the source. However, the extent to which land values change because of the externality is also sensitive to the potential of household migration as well as income of the nearby households and initial levels of property values. The effect of negative externalities is greatest where households can choose alternative sites. Hence, externalities often follow a geographic pattern of distance decay.

A study of Hamilton, Ontario housing values supports the theory that negative externalities decreases land values (Thrall, 1979). Several neighborhoods within Hamilton stood out as having significantly less market value than their assessed values would otherwise indicate; those neighborhoods received particularly heavy concentrations of smoke from harborfront steel mills, or had a high density of noise from surrounding industry. Those locations affected by noise also showed significantly lower market values than otherwise expected with increasing proximity to the site of the emission thereby suggesting the presence of a distance decay effect. All houses in Hamilton were assessed using the same accounting formula; the formula was intended to estimate the cost of rebuilding the structure at present market values. At the time of the study, neighborhood effects of externalities were not considered in the assessment of the property. Based in part upon this study, the method of property assessment for tax purposes was changed in the Province of Ontario.

The study of Houston by Bullard (1983) provides descriptive support for the externality hypothesis. Houston does not have a strong zoning program, so there are few avenues for householders to protest the location of noxious facilities such as solid waste sites. One-hundred percent of the population surrounding Houston landfills is black, and 80% of the population surrounding incinerators is black. These black households also tended to be lower income with houses of relatively low land values.

2. Externalities and Local Economic Growth

The principal reasons for industrial location are well documented in the geography literature (for example, see the following: Berry, 1969; Lloyd and Dicken, 1977; Smith, 1979; Webber, 1984). In order of importance, the general reasons for industrial location are:

[i.] low labor costs;
[ii.] agglomeration economies;
[iii.] transportation costs for raw materials and finished product;
[iv.] venture or risk capital.

Agglomeration economies are the benefits (positive externalities or spillovers) a firm receives from the presence of other firms with the same infrastructure requirements. Florida, it should be noted, has the highest average manufacturing wage rate in the Southeastern portion of the United States.

Population size can cause small cities (less than 250,000 persons) to be at a disadvantage when compared to larger cities in terms of one or several of the above listed four points, leaving the small city in a low level equilibrium trap for economic growth. The push for economic growth can come from the attraction that some people or types of commerce have to the amenities of an area: clean air, nice weather, plentiful public parklands, and perception of the city being aggressive in supporting a long run attractive environment. Amenities generally are critical when the choice of location lies between two otherwise identical places; the area with greater amenities will receive the industry or inmigration of people.

A decrease in amenities because of pollution can contribute to a no-growth scenario for small places. The major reason for migration within a city is to obtain housing commensurate with one's income and position in life cycle (single, married, with or without children, and so on); most of these moves are short in distance. Migration between regions is largely the result of employment opportunities, recreation retirement, and, to a lesser extent, gaining access to favored amenities (Clark, 1986). Local movers will not be attracted to areas immediate to solid waste land fills.

III. RELATED ECONOMIC LITERATURE

The economic literature on household solid waste has focused upon the cost of refuse collection, particularly the cost difference between municipal versus private contractor refuse collection. The general conclusion of this literature is that no significant difference exists for small cities (less than than 50,000 persons); private contractors are less expensive for intermediate sized cities if they are also in charge of billing the individual customers; large cities (over 500,000 persons) can expect a reduction in the price of services if they have mixed methods of refuse collection -- that is with some sectors of the city using private contractors and other sectors using municipal employees (see Hirsch, 1968; Kemper and Quigley, 1976; Petrovic and Jaffee, 1978; Clark, 1978; Savas, 1979).

IV. DISCUSSION

A. General Overview

Both incineration and burial of solid household waste affects the surrounding neighborhood or region. The negative effects from solid waste burial sites are likely to be most intense at the site, then quickly lessening with decreasing proximity to the site (distance decay of the externality). Land values are expected to be inversely related to the negative spillovers or externalities (Thrall, 1982). Because the effect is most intense at the site and steeply declining with distance from the site, the following can be stated:

> **Principle 1: Land values will vary inversely with proximity to a solid waste sanitary landfill site.**

The negative externalities from an incineration facility can be expected to be less intense at the site than if the waste burial technology were employed. At the same time, the impact from a burning facility covers a much broader area because of the carrying capacity of the atmosphere and the amount of particulate matter emitted to the atmosphere; conceptually, the externality function from a solid waste incineration facility conforms to a relatively flat rate of distance decay about the site. Thus, the following can be stated:

> **Principle 2: Land values will decrease following the introduction of a solid waste incineration facility, but this decrease will be relatively spatially uniform; except for those properties immediately adjacent to the incinerator, land values will not be strongly dependent upon the proximity of the incineration facility to the site.**

The negative externalities from solid waste incinerators or for example a pulp and paper mill can overshadow the amenities (positive externalities) of an otherwise attractive small place to the extent that other industries will not locate nearby. The small place is then captured within a low level equilibrium trap of non-development. Because amenities are generally of minor importance in attracting industry to large cities, the hypotheses can then be stated:

> **Principle 3: The optimal economic growth strategy for small cities is to maintain their amenities by localizing negative externalities as much as possible, in this case possibly by disposing of solid waste by burying it and by minimizing the amount of refuse that need be buried by recycling.**

> **Principle 4: Because amenities play a lesser role in**

attracting industry to large places rather than small places, and also because atmospheric pollution may already exist in large places, large places will be more likely to adopt solid waste incineration facilities than small places. Therefore, small cities should not consider the strategy of large cities as good examples that they should follow.

Principle 5: Small places that already suffer a lack of amenities because of the presence of such an industry as a pulp and paper mill or already having used earlier incineration technology, will be more likely to adopt modern solid waste incineration facilities than other places. Such cities simply have few remaining amenities that will be lost from adopting incineration technology.

B. Summary Statement

As regions economically develop and increase in population, they must address the problem of disposing of the increasing amounts of solid household waste; disposal of solid household waste is basic to the infrastructure necessary for growth. Increasing population must be accompanied by increasing facilities to receive solid waste.

The negative externalities from solid waste incinerators or burial sites will lead to significant decreases in land values especially for those neighborhoods immediately adjacent to the site. However, if the land values are already low, and if the households there have few or no alternative sites to choose between for their housing, then land values will not be expected to have a significant decrease. Moreover, low income people often do not participate in the political system to the extent that higher income households participate. For these reasons solid waste sites have often been situated in the lower income urban neighborhoods or the poor rural areas that surround municipalities.

Because of the externality density function, politicians often select the solid waste site to be on the border of the government jurisdiction; in that manner, roughly half of the negative externalities fall upon a populace unable to vote for or against those politicians.

Once a site has been established it may deter the immediate region surrounding the site from further economic development. Moreover, there is a significant possibility for groundwater contamination from both burial and incineration plants. For these reasons, it has become increasingly difficult to find acceptable and accessible sites for solid waste.

However, under certain circumstances the negative economic effects of solid waste sites can be offset by [1] increased local employment, [2] inexpensive power, and [3] appropriate incentives.

[1] Solid waste incineration facilities can lead to a net increase in employment in the local area. The average sized plant employs between 50 and 100 persons. The solid waste industry employs labor that is largely unskilled, relatively high paid for the requisite skills, and often come from minority groups. At the same time, solid waste disposal has been cited as being one of the more dangerous occupations in the United States (Stone, 1978).

[2] Installation of solid waste incineration facilities can produce inexpensive electricity as well as reduce by about 80% the volume of solid waste that needs to be buried. If the power were to be priced so that it was particularly inexpensive within the zone impacted by the negative externality, the negative effects may be not only offset but can become an incentive for industry to locate in the impacted region.

[3] Impact fees are now considerd a standard and necessary inducement for places to accept solid waste sites. The State of Massachusetts pays $1.00 per ton of solid waste buried or incinerated to any community willing to accept such a facility. The City of Los Angeles is paying a centrally located low income Black neighborhood to accept a solid waste incinerator that will process 2,500 tons of refuse each day; the neighborhood will receive $1.00 per ton in addition to $10,000,000.00 in up-front fees. Revenues can be used by the neighborhood for whatever purpose they choose, such as intensive education programs.

To sum up, burial of residual ash can contaminate underground water supplies; poorly managed plants can lead to noxious and hazardous air emissions which can negatively affect a large region. Those regions that rely upon amenities to attract industry and commerce may then be reluctant to install incineration facilities. However, sufficient impact fees and possibly inexpensive power can be a mechanism for local economic development and individual household gain. Impact fees do not however reduce the importance of using the environmentally best available technology in solid waste disposal, nor will such incentives necessarily overcome opposition to solid waste sites in all places.

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FEDERAL GOVERNMENT RESPONSIBILITY, LAWS AND REGULATIONS

Jim Scarbrough, P.E.
U.S. Environmental Protection Agency
Region IV
Atlanta, Georgia

I want to talk to you this morning about where we are in Region IV. I hope that everyone knows that Region IV is those eight southeastern states that the gentleman had on the map a few minutes ago. Our office is in Atlanta. We don't have district offices or state offices. We do our work out of the Atlanta office, with the exception of our laboratory which is in Athens, Georgia.

I run the RCRA program. That is the federal act under which we regulate hazardous waste. This Act was passed in 1976. It took us about four years to get a set of regulations developed, which we in the regional offices, could implement. In that first set of regulations were standards for generators of hazardous waste; transporters; treatment, storage and disposal facilities. The Congress envisioned this program being delegated to state government, if they so chose. We're fortunate in the southeast in that seven of our eight states have chosen to run this program in state government, Florida being one of those. You will hear from the DER. They run the hazardous waste program and we provide funding and oversight. Alabama is the state that does not presently have authorization for the basic RCRA program.

The Act was amended in November 1984. It broadened the scope of our activities tremendously. The Congress, in its wisdom, stipulated that the Environmental Protection Agency is required to implement those provisions in authorized states as well as unauthorized states until the states pick up those requirements.

I'm going to tell you a few things that are included in those amendments and give you some idea what we're doing. The size of our program is such that we have more on our plate, combined with the states, than we can handle. We have intense scrutiny from the Congress. We have intense interest of the environmental groups. We have intense interest of the public, the media and this program is one of the few programs in the federal government that continues to grow in this day and age. The Superfund program, as you probably know, is presently unauthorized and in what we call a "slow down phase," while the Congress debates what we're going to do next with the Superfund program.

It's important to remember that the 1984 amendments are being implemented by the federal government in Florida as well as the other states. We have new authorities for corrective action that we didn't have before. For instance, if you need a permit for storing hazardous waste at your manufacturing facility and you have an old landfill out back, in order to get your permit you're going to have to evaluate that old landfill and determine whether or not there have been releases to the environment from that landfill. If there have been releases, you're going to be required to define those releases and if corrective action is needed, you're going to be required to implement that corrective action. If you choose, upon finding this out, not to want a permit and only store less than 90 days, we have been given the authority to require you to do all those things through our enforcement authorities.

These amendments have a requirement for double liners for landfills. Previously, our regulations required one liner. Now, you have to have two. You have to double line surface empoundments, if you're going to continue to use those to store hazardous wastes. There was a provision which stipulated on November 8, 1985, that land disposal facilities have to certify to the agency compliance with the ground water monitoring requirements, the financial responsibility requirements, and they had to submit their permit application, if they hadn't previously done that. We're presently sifting through those certifications. We are finding people who certified who should not have. We're finding people who didn't certify who continue to use those regulated units which is a direct violation of the law. We're finding people who certified and certified correctly, and we're finding people who chose not to certify and to cease using those units and handle their waste in other manners.

In the Region IV eight southeastern states before November 8, 1985 we had about 275 land disposal facilities that were in operation or had previously been in operation in the near term. Now, we only have about 75 of those left that are actively seeking permits to operate land facilities.

These amendments also have a bulk liquid prohibition. You can't put bulk liquids on the land anymore. There's a direct prohibition. We also have coming up containerized liquid prohibition. We'll be promulgating regulations soon on containerized liquids.

You heard mentioned before of the small quantity generators. We lowered the regulated level from 1,000 kg./month to 100. Some states already have that. Some states are going to zero. South Carolina has been at 100 all along, since they set up their program.

We have a prohibition on containerized liquids as I said and we also have a requirement to write regulations about how we use used oil. We have requirements out already for burning and blending. These have to do with waste derived fuels. We have a requirement for waste minimization. People have to make efforts to minimize the amount of hazardous waste they are generating and certify to the agency that they are so doing.

Those are some of the things that are the most important in the amendments. There's one other that I think probably the overall effect is going to be much more than some of these I mentioned, and that is that we have to examine the listed waste streams and make a conscious decision as to whether or not those waste streams are going to be allowed to be placed on the land. We have to go through the listed waste streams individually. We just promulgated a proposal on how we're going to do those evaluations and the criteria. It was in the Federal Register two or three weeks ago. It's quite controversial as to whether or not we're doing what the Congress instructed us to do.

Keep in mind now that the Washington office writes the regulations and promulgates them, we in the regional offices are charged with implementing those regulations. If the state is delegated, then what the state will have to do is pick up almost similar requirements and promulgate those as regulations in state government, and then they are charged with implementing those regulations with our oversight. The priorities for us in this day and age are as follows.

In the regional offices, first of all, the obvious thing we have to do everyday is, if we encounter situations that endanger public health and the environment, imminent hazards, we must deal with those and deal with those quickly. As I mentioned, the loss of interim status on November 8, 1985, we're working as hard as we can to sort those certifications. If there are frivolous certifications, if there are false certifications, if people are using units that they did not certify, then we will be taking enforcement action, either administratively or we'll be going to federal court.

We are looking at the groundwater monitoring requirements. This is a very intense area that we have oversight from the Congress and rightfully so. We're looking intensely at whether or not people are in compliance, strict compliance with the groundwater monitoring requirements. That is, as they remain under interim status which is the state that they are in until they receive a permit. We are also giving intense scrutiny to the permit applications to see that when we get ready to issue those permits they're going to have a groundwater monitoring system or compliance monitoring system or corrective action program in that permit which will correct any problems or detect any problems.

We have a requirement of financial assurance, including sudden and non-sudden liability insurance. That's a real problem these days. People can't get liability insurance and we're taking enforcement action either through our agency or through the authorized states of people that are supposed to have insurance and do not have insurance.

We have a Congressionally mandated date of November 8, 1988 when all land disposal facilities must be permitted. That's quite a large job. It may not sound like much with 75 or so facilities getting a permit by 1988, but I assure you it's a tremendous job. These requirements to get a land disposal permit are quite stringent, lengthy and cost a lot of money. As we move toward 1988, as we encounter people who are not serious about meeting the permit application requirements, what you're going to see is that we will deny their permit or the state will deny their permit. We have to get serious about meeting the 1988 date.

The next priority is for alternate capacity. We are concerned that capacity is a problem and is going to be more of a problem as we proceed in time. We have to give top priority to people who want permits for alternate capacity to land disposal. You heard the things Mr. Shuster had to say about land disposal. We think land disposal is the last alternative that should be used. Presently, lots of waste are going on the land that could be treated and sorted or handled in other fashions.

We are concerned and interested and give high priority to research permits. We have the authority now which we didn't have prior to 1984 to issue research and development permits. We think those are important. We don't want to stifle people with new ideas. If you come forward with a new idea on how to treat a hazardous waste or do something with it better, then you're going to get top priority from us to get you a permit and let's see if you can do that.

I mentioned earlier the corrective action authority we have. This is an area that's going to cost people that have old disposal sites or old solid waste management units a lot of money. It's going to cost a lot of money to get those cleaned up. So, the authority that we have now is similar to the authority in the Superfund Act for old or abandoned sites. We now have the authority to require the same sorts of corrective measures on any manufacturing facility.

In order to get a RCRA permit even in an authorized state, right now you have to get it if you have one of those solid waste management units on your property, you must get both a permit from the state and a permit from the Environmental Protection Agency. The Congress structured those amendments such that in order to have a RCRA permit you have to have both at this point in time until the state agency picks up the requirements in the 1984 amendments.

Rather high priority portions of our work have to do with evaluating applications from the states if they chose to run their own hazardous waste program in lieu of federal government. Then, when that takes place we have to provide oversight to the state enforcement program. We provide oversight for the state permit program. We administer the grants to the states to help them fund their regulatory program. The Congress has stipulated in the Act certain mandatory inspections. We must by law inspect all federal, state, and local hazardous waste facilities if they are locally owned, state owned or federally owned. We must inspect those. We can't allow the state to inspect them for us. We have a large initiative right now in federal facility compliance. The administration thinks that federal facilities need to lead the way as far as being in compliance with environmental laws. In the case of the hazardous waste program, they are not the leaders and often times they lag.

So, that's one of our high priorities, to get these federal agencies in gear and in tune with everybody else as far as having their facilities that handle hazardous waste in compliance with federal as well as state law.

I hope I've been able to give you some idea of what we're doing in the regional office of the Environmental Protection Agency. We are awfully busy and we don't have time to do a lot of the nice things that we used to do. It's not very often that I get to go to, what I like to consider, a somewhat friendly gathering of people. As I said in the beginning, most gatherings I go to are somewhat tense. People are at odds over an enforcement action or a permit action or a public hearing on a permit or whatever and I appreciate your attention.

STATE GOVERNMENT RESPONSIBILITY, LAWS, AND REGULATIONS

Robert McVety
Chief
Bureau of Waste Management
Florida Department of Environmental Regulation
Tallahassee, Florida

What I would like to do is tell you a little bit about what's happened over the past six years where I think we've seen a growth in the interest of proper management of both solid and hazardous waste.

In 1980 our legislature passed the basic framework to allow the DER to establish a hazardous waste program similar to the one that you just heard about at the federal level. Since that time, we have developed regulations that are in essence identical to the EPA's standards. One note that I'd like to perhaps clarify from the last speaker, when you asked about the double liners for landfills by 1988. That's just for hazardous waste landfills. We don't have any commercial hazardous waste landfills in Florida. Solid waste landfills and municipal waste landfills are not covered by that federal regulation.

In 1983, the legislature passed perhaps the most far-reaching environmental legislation in the last 10 or 20 years by the passage of the Water Quality Assurance Act. Many environmental issues were included with particular emphasis on solid and hazardous waste. It established a fund for cleaning up hazardous waste sites. It established the Amnesty Days program that Senator Kirkpatrick spoke of this morning. It established a local hazardous waste assessment program. This afternoon's session will have a DER person explaining what was done under that program.

The law called for the establishment of a multi-purpose hazardous waste treatment facility in the state. It banned future hazardous waste landfills, but it said we need to find a facility or have a facility that will treat the wastes that are generated in the state. Alabama and South Carolina have the nearest landfills for disposing of hazardous waste. We need something in Florida to treat it. Not a landfill, but a treatment of some sort. Congress reinforced this in the amendments to the RCRA law that we heard a little bit about earlier. I had said that certain wastes cannot go to landfills. So, we can't continue to take our solids to Alabama in the future because these wastes will very likely be banned from that landfill.

The Water Quality Assurance Act established a storage tank program. A regulatory program whereby DER is to regulate above and below ground storage tanks. We have passed a rule in that area. I'm proud to say we were the first state in the country to do so and that is just getting off the ground.

In the solid waste area, the law required people who were disposing of solid waste on their own property to notify the department. In the past we weren't told of this activity and permits were not required. The law called for the department to issue permits for the closure of landfills, recognizing the need for proper closure of the solid waste landfills. That was in 1983.

In 1984, there was a growing recognition of the solid waste management problems. Our rules banned the disposal of hazardous waste in solid waste landfills without prior permission from the department. We did a survey of the Water Quality Assurance Act and we're projecting about 9,000 tons of hazardous waste are going to the solid waste landfills. No one's asking permission, but they filled out the survey and told us this is what they were doing with their wastes. As a recognition of the problem that many of these wastes were going to the solid waste landfills, even though we had rules and laws that said they couldn't, the legislature funded a study on how to properly close existing landfills and directed us to develop standards to better manage solid waste landfills.

Using this study that was conducted by the University of Florida for closure, the department adopted regulations for properly closing landfills. In this rule we required that landfills be covered, that you put a cap on it, so when it rains the water doesn't drip down into the landfill and continue to leach the garbage and the wastes that are in the landfill on down into the drinking water supplies. We said you must control the leachate that's in the landfill. We said you must control the gas that's created by the decomposing garbage and manage the stormwater that might be running off the landfill. Also, monitor the groundwater in the area. Finally, record in the property deed that this was a landfill, so when someone buys the land sometime later they know what they're getting or at least have been put on alert that there might be something there. The rule further requires some financial assurances for proper landfill closure. If a landfill is in operation, it must submit closure cost estimates to us and also provide assurances that it can pay those costs when it's time to close the landfill. If someone has a privately owned landfill and skips town, we want these funds available so that the state can come in and properly close the landfill. If it's a publically owned landfill, plans are to be prepared and submitted to the department by July of this year showing how the local government plans to cover the costs of proper closure.

The 1984 Legislature established a used oil registration program, so that we are learning who the collectors, transporters, and recyclers of used oil are. It also asked us to encourage used oil recycling and we're trying to establish a program in this regard.

Additionally, the 1984 Legislature required DER's solid waste permits to control the surface and groundwater or movements of leachate into surface and groundwaters as well as look at the need for liners, solid foundation under the landfill, as well as leachate control, gas control and stormwater run-off. As a result of that directive, the department began working on a construction rule for landfills. In October 1985, we did adopt a rule that called for liners to all landfills.

So, we've got a liner system or something under every landfill that's going to be constructed in the future. We've got wells around the outside of the landfill to detect if contamination is leaching out through the liner which we hope it isn't. We also require that you put some kind of leachate control system into the landfill, so that you can pump the leachate or the garbage juices out so it doesn't try to penetrate the bottom of the landfill. Then, in our closure rule, we have a cover requirement. So, you have this little box full of garbage, and you maintain it for 20 years continually drawing the leachate out. Hopefully, this will help better protect our groundwater supplies.

The 1985 Legislature passed a state comprehensive plan. It called for the management of all solid and hazardous wastes in a proper manner. One of the goals was to by 1995 reduce the amount of solid waste going to landfills by 55 percent. This is going to take some sincere efforts in the resource recovery field. Florida is already a leader in this regard as we've heard this morning.

In the hazardous waste program, in 1985, the Legislature established a grants program, so the counties and local governments could build transfer stations to help avoid the wastes or reduce the amount of wastes that are going into their local landfills. $50,000 is available per county to build these transfer stations. No one's applied for a grant yet. I encourage you to urge your county commissions to apply for these grants.

Let me close by saying that I think both solid and hazardous waste have received a considerable amount of attention in the 1980s. I think we've already accomplished a lot, but we've got a long way to go.

LOCAL GOVERNMENT RESPONSIBILITY, LAWS AND REGULATIONS

William Brandt, P.E.
Department of Pollution Control
Metropolitan Dade County
Miami, Florida

I'd like to speak to you about what local governments can do to deal with solid and hazardous waste issues and how to work cooperatively with state agencies. I'm going to mix my comments about what Dade County government is doing, what we are going to do, what we'd like to do, and then, what we'd like to see the state do to complement our work.

We in Dade County believe that any hazardous waste and solid waste program requires both state and local effort. We're very proud of our effort in Dade County, but there's no denying that we need the state to support our program. There are some things that are better done by the state and some things that are better done by counties. We're trying to make that distinction between the two. Neither the state nor the county can do it all.

First, I'd like to speak about what we're doing in Dade County with our solid waste problems. Back in the early 1970's, we recognized that we were going to have a solid waste disposal problem given the environmental conditions in Dade County and the Biscayne Aquifer. Even though the environmental movement was just getting underway in the early 1970s, we had enough awareness to realize we couldn't continue to operate a dump, which is what we'd done since the 1940s and 1950s.

So, we began a plan to get rid of our dumps. We organized a task force which recommended a master plan to the county commission. The county commission reviewed the master plan and approved it. The plan called for the elimination of all our landfills and dumps and replacing them with a resource recovery facility.

We began planning for our resource recovery facility around 1975. It's now been operating for about the last three years and is the largest resource recovery facility in the world. It processes 18,000 tons per week of solid waste. The process that is uses is a front-end separation process. It will take the solid waste, mash it up, and then it will recover the ferrous metals, the non-ferrous metals, brasses, coppers, and that type of material. It even recovers coins. I think we get about $20,000 a year worth of coins out of our garbage plant. It recovers glass and it generates electricity. The remaining organic material that's left is shredded, hydropulped, dried and then burned. It generates enough electricty to provide electricity for approximately 40,000 homes which is about the size of the City of Hialeah. It's definately a very viable electricity generator.

The plant cost us about $140 million back in 1977 dollars and was financed entirely by Dade County revenue bonds. We asked the state's cooperation in helping us sell pollution control revenue bonds and they helped us a lot. We were able to get the bonds and we're happy that we spent 1977 dollars, because I understand Broward County went out for bids on a similar resource recovery facility and the bids are four or five times higher than what we had to pay. We have had some problems with the facility, but we're working on that.

If you're with a local government and you really want to solve your solid waste problems through a resource recovery facility, you're going to need countywide authority. I know some counties have a problem with this. They can't mandate certain things over cities regarding solid waste collection and disposal, but you need that authority. Basically, you have to be able to monopolize the solid waste market because you can't be competing with cities who would build landfills because the tipping fee would be cheaper for them. If you need resource recovery, you need countywide authority to monopolize the solid waste in your county.

A few years ago after our resource recovery facility came on-line, we became aware of small quantities of hazardous waste in the solid waste stream. I think everybody has the same problem, but when you operate a labor intensive facility where people are coming in contact with the waste, you become more concerned about their well-being. So, we began a program of inspecting the incoming solid waste. We now have inspectors spending time on the tipping floors, calling a truck off to the side occasionally and going through it literally with rakes and brooms to see what kind of hazardous waste is in there. Obviously, you can't get it all, but it has a tremendous deterrent effect on people who would otherwise dump, because if the truck driver is caught he's cited and he will go back to the person from whom he got the waste. Of course, we obtain that information from the truck driver and the source of the waste is responsible for cleanup which is very expensive. So, it's becoming more attractive for people to handle their waste properly.

Another thing we're doing with solid waste is very, very recent. The county manager has now decided to look into the issue of recycling. He is in the process of appointing a recycling committee. Even though we have the largest recovery plant in the world, he still wants to look into other ways of recycling and perhaps reduce the need for more resource recovery facilities in the county or at least minimizing the need.

My staff and I spend the majority of our time on the hazardous waste issue. There's such a wide variety of problems regarding hazardous waste and there has to be a wide variety of approaches to managing hazardous waste, especially for a county the size of Dade with the variety of industries that we have. I can't go through all the programs that we have in detail. So, I will focus on one of the programs that I think is a universal problem and is a statewide concern. Then, when I'm finished, I will list some of the other programs to let you know what we're working on.

The one that I want to focus on is small quantity hazardous waste generators because that's the topic of concern these days. When we in Dade County look at small quantity hazardous waste generators we look at it in two categories: existing businesses and new businesses. That's how I'll speak to you about them because we have some different rules for new businesses.

Let's talk about existing businesses first. There's really two things that you need to do when you're trying to, as a regulatory agency, get a handle on the small quantity hazardous waste generators. The first thing you have to do is identify who the generators are. This was done, again, in a cooperative effort with the state. The Water Quality Assurance Act of 1983 provided funds to the counties to inventory for the very first time all the small quantity hazardous waste generators in the county. It was a tremendous task. We started out in Dade County, I think, with about 13,000 names of businesses that we had to sort through and find out who did and who did not generate small quantities of waste. It took us a year.

After you have the first task accomplished, which most counties have by now, then you have to assure proper management of the waste which is the hard part. This is what I think is a real good example of how counties and state agencies can work together. I don't see any way that either of the agencies can do it all in this issue of small quantity hazardous waste generators.

Let me speak first about what Dade County is doing. We believe that our job, as a county agency, is to get the industry's waste to its front door. It sounds like an elementary task. But when a person has been steam cleaning in his backyard for 20 years and he's used to letting the waste drop in the ground, he doesn't consider himself to be a polluter because he's been allowed to do it. So, it's a process of educating him and changing his method of making his living. You can't do that overnight.

The small quantity generator problem is such a concern because there's literally thousands of companies with which to deal. It seems like they're all different, their waste is different, and no two cases are the same. How is it done in Dade County? We deal with these thousands of different types of businesses through a system of operating permits, but we do it a little bit differently. We don't have real tough criteria for obtaining an operating permit. In fact, we give the operating permit fairly freely to people who may be in violation, but then we use the operating permit as a tool to make them come into compliance. We have a simple provision in our county code which states that anybody who may be a source of water pollution must have an operating permit. So, it gives us a lot of latitude, a lot of discretion, and a lot of flexibility. We notify people who may be a source of water pollution, such as small quantity generators, that they're obligated to have an operating permit. Then, we have another little section in our county code that says that we can put provisions in the operating permit which must be adhered to by the permittee.

Again, we use the operating permit system as a way of educating the people. First, we tell them they need a permit, so they get the permit. Then, we tell them what they need to do to come into compliance with our regulations and the state regulations. So, it's an ideal way to communicate with the people and it's an ideal way to educate the people as to what their obligations are. It's also enforceable. I'm also the local environmental regulatory agent and I have to go through enforcement activities quite often. But the success that we've had with the operating permit system makes me feel very confident that it is a very enforceable document. So, the conditions on it can be enforced through a court of law and we of course have done that.

Since the 1983 Water Quality Act and 1984 when we actually did the survey of small quantity generators, we've begun notifying and telling all these small quantity generators that they have to have permits from us and they have to cleanup. So far, we have about 1,100 of them permitted. We've identified about twice as many that still need permits and we're dealing with these people trying to get them permitted.

The next step after issuing the permit to these people is to tell them what they need to do. The first thing we tell them that they need to do is to clean up any ground or groundwater that they've discharged in over the years and contaminated. We work with them on the design and the completion of the cleanup. The second thing they need to do is build some kind of a facility to make sure that what happened before doesn't continue to happen and doesn't happen again. We're requiring just a very nebulous term of "best management practices" which is kind of an ill-defined thing for these different types of businesses. We generally try to go with whatever technology will provide for that type of a waste product. But they must, in almost all cases, build some kind of a system. If its the steam cleaner, for instance, he's got to build a concrete ramp with a sump and a drain and a tank.

Basically, what this does is it gets these people who have been allowing their waste to go under the ground to capture or containerize their wastes. That's what I meant before when I said that we think that the county's job is to make these people get their waste to their front door. Once they've stopped spilling it and having convenient accidents, they can containerize it and get it to the front door. That's what we think our operating permit system will do.

At this point, our operating permit also requires them to have a contract for pick-up of the waste. However, when it leaves their property is when the separation between county and state begins. We're very happy that the state apparently agrees with us (or we agree with the state) because the state has made efforts in the past few years to try to stimulate construction of disposal facilities and getting people into the business of door-to-door pick-up. That's really where we're going to have a weak link in the very near future--door-to-door pick-up. The state has come up with a $50,000 grant proposal. We've reviewed it and have tried to do something with it. Unfortunately, in Dade County it's just not enough and we're asking the state to try to increase that amount.

I have a few ideas for the state. We think that the state could go after chemical distributors. Chemical distributors are already in the business of distributing chemicals. It seems to us that they could take the waste from their clients back to their businesses and then have that picked up. So, the chemical distributor could be a centralized facility for receiving waste. We also think the state could come up with better incentives or more incentives, such as paying the insurance policies for some of the hazardous waste facilities and perhaps tax credits. We think the state could come up with a proposal to make the operation of a facility appear to be free through the use of some excise taxes or optional sales taxes or even franchise fees. We also think the state could more appropriately than the county come up with an operator's certification program to require managers and operators of hazardous waste facilities to complete a state training program.

That's all for existing businesses. I just want to inform you about something we've had in place for the last five years in Dade County for new businesses. We began studying water quality relationships in Dade County in the late 1970s and we were able to show a very definite relationship between water quality and the type of land use overlying the water. We found that industrial land uses resulted in chemical contamination of the underlying water. It seems pretty obvious but we were able to document very carefully what was happening and how it was happening.

So, our county commissioners asked us, "How do we prevent these chemical contaminants from getting into our drinking water, especially around our wellfields?" We gave them a proposal which they adopted in 1981 which basically said that the best way to be absolutely sure that you don't have chemical contamination of your wellfields is not to let businesses that use hazardous chemicals into the geographic areas around wellfields, the watershed areas. This is what the county commission did. It was a big bullet to bite back in 1981 and it created controversy. Basically, it banned new industrial land use around our wellfield protection areas, one of which is 80 square miles. The other thing the county commission did in the remaining areas to protect the remaining portion of our water supply in our aquifer was to ban industrial land use unless sewers were made available.

That sums up our small quantity hazardous waste generator program for both existing and new businesses. Now, I'll list some of the other programs that we have going within our department. These affect both new and existing businesses for the most part. Dade County in 1983 put together the first underground tank ordinance in the state and we've been implementing it ever since. We have about 55,000 underground tanks which are permitted now. We also have a program whereby anybody that transports any kind of a waste at all has to be permitted by the department and receives regular inspections and makes reports. There's about 110 businesses that are permitted by us to transport wastes. That would be septic tank, waste oil, and of course hazardous waste.

We have a special program for our airport. Miami International Airport has received a lot of attention as a place where a lot of fuel is leaked and there's no doubt about it. The county has spent several million dollars in the past couple of years trying to clean it up and we have three people assigned permanently to monitor the airport progress.

Our county has also tried to respond to the need for hospital waste disposal. We have leased property to a person who is in the business of hospital waste disposal. He couldn't find any property that would be suitable for his facility, so we were able to lease him some property which enabled him to get in the business and solve the problem.

We also have a waste oil recycling program that the county sponsors. Of course we get into enforcement, but we also get into cleanups. At this time there's about 72 chemical types of cleanups ongoing in Dade County that we're supervising. We have, as I mentioned in our underground tank program, about 80 underground tank leaks for which our department is supervising the cleanups.

A few years ago we created a trust fund because we were having instances where a truckload of drums would show up on a county right-of-way or we would get a drum that floated up on a beach. We've had drums show up in the funniest places at the funniest times and we didn't really have any budgeted money to handle this. We didn't even have a contractor who could respond to it. The county didn't want to deal with it because of the nature of what you can get. So, we established a trust fund and we now have a contractor who can respond to these types of things and has done it quite frequently.

One thing that we're fairly proud of in the county is we went to the industry a few years ago and expressed an interest in them and in creating some kind of a forum to where we as a regulatory agency could meet with the industry on an impartial or unbiased setting. They agreed and created a new trade association. It's called the Industrial Environmental Trade Association of Dade County. It's been in existence for about two years and the purpose of it is to give us a neutral forum where we can both speak to each other and bounce ideas off each other. It's been very helpful and I think other counties and perhaps the state could pick up on this and they could form statewide or other county industrial environmental associations. In fact, the association has expressed an interest in sponsoring their own Amnesty Days for Dade County and they're soliciting donations now.

We're very fortunate in Dade County. We solicited from the industry that is in the hazardous waste business. We tried to get some people interested in building a transfer station in Dade County. We didn't get too many, but we do have one person right now who is interested in building a recycling facility for hazardous-type wastes. He's gone so far as to apply to the county for industrial development bonds and he's been cleared for the sale of those bonds. Also, the county will be leasing him property in a very good location. What he's going to do is recycle oil. He'll recycle solvents and he'll have an incinerator for residual organic sludges.

One more thing, we have three ordinances that we are developing. We spent the last six or seven months developing these ordinances and I think they're fairly unique and innovative and I think they could be applied around the state. One of the ordinances I copied from New Jersey. That ordinance will require certain industrial properties with high contamination potential to, on a routine schedule every 3-5 years, have an environmental audit of their property. They'll have to hire a consultant, take soil samples, take water samples and prove to us that there hasn't been anything that we haven't caught during that 3-5 year period.

The second ordinance that I'm really proud of and I'm sure its unique, will allow us as a county agency to actually loan money to industries that need to do small cleanups. Viable companies are always coming into my office saying, "Look, I'm a small guy. I don't have $10,000 to do this cleanup and it's a real hardship for me to get it. Banks don't really like to loan money to dig up dirt." So, we're coming up with a program that will actually allow the county to loan money out to people who are reasonably good risks and let them pay us back at a low interest and over an extended period of time.

The last ordinance will establish a soil standard for the county. It's constantly a problem everywhere. How much do you clean up? We're trying to answer that through this ordinance which will tell people how much contamination the soil can take.

I want to go back to my original statement that we feel very strongly that any county, no matter how big or small, has to work with DER very carefully. There are definitely things the state can do that counties can't do and visa versa.

INCINERATION OF SOLID WASTE

WASTE INCINERATION: REGULATORY AGENCY PERSPECTIVE

I. Introduction

Good afternoon. My name is Julie Cobb, and I am an attorney with the Florida Department of Environmental Regulation.

I am going to highlight the Department's regulatory actions concerning resource recovery facilities in the State of Florida. While I will strive to remain objective, its possible that an opinion or two may surface during my presentation. If this should happen, please remain calm, and please remember that any opinions I may express are mine solely, and do not necessarily reflect the Department's view on that issue.

The phrase "resource recovery", as you may know, is not limited to waste incineration. Waste reduction, reuse, landfills and composting are also included in the term. But these are all topics for other panels, and I am going to limit my comments to waste incineration.

II. 1985 Activity Report

The Department each year compiles and distributes a document entitled the State of Florida Resource Recovery Activity Report. This annual publication provides current information on resource recovery-related developments throughout the State of Florida.

I intend to summarize the waste-to-energy statistics contained in the 1985 report.

There are presently 6 waste-to-energy facilities in operation in the state. The capacity is 6,460 TPD.

There are 3 facilities presently under construction. Their total capacity is 2,350 TPD.

In the planning stages, there are 16 facilities, with a known capacity at this time of 13,125 TPD.

Clearly this indicates that the climate in Florida is conducive to the development of waste incineration facilities.

The Legislature has enacted favorable financing and tax exempt provisions which encourage this technology.

Other information about waste incineration include these facts:

- o The projected combined capital costs (which includes both public and private) of waste-to-energy facilities currently in operation, under construction, and on the planning boards for the next 10 years is estimated at 1.6 billion dollars.
- o Assuming that two tons of solid waste (when burned) represent the energy equivalent of four barrels of oil, the known capacity of resource recovery facilities now under construction, in operation, or planned in Florida would theorectically replace the energy equivalent of 40,000 barrels of oil per day.
- o The majority of the waste-to-energy facilities planned, under construction, or in operation utilize or are going to utilize mass burn technology, which means no preprocessing of the incoming wastes.
- o Each facility creates new employment opportunities, and thus, is a natural ally for economic development in Florida.

o Waste-to-energy facilities, when properly designed and operated, can enhance Florida's environmental protection of its natural resources.

o Increased resource recovery can help decrease amounts of wastes which must be buried in the ground, thereby decreasing the potential for pollution of ground or surface water.

The Florida Comprehensive Plan calls for a 55% reduction of the current volume of non-hazardous waste going to landfills by 1995. Currently projected resource recovery activities over the next ten years should enable Florida to reach this goal.

III. History of Regulatory Aspects of Resource Recovery

In 1974, the Florida Legislature enacted the "Florida Resource Recovery and Management Act."

The purposes of the act, which is found at Part IV of Chapter 403, include to:

> (a) Plan for and regulate in the most economically feasible, cost-effective, and environmentally safe manner the storage, collection, transport, separation, processing, recycling and disposal of solid waste in order to protect the public safety, health, and welfare; enhance the environment for the people of this state; and recover resources which have the potential for further usefulness.
>
> (b) Establish and maintain a cooperative state program of planning and technical assistance for resource recovery and the program management.
>
> (c) Provide the authority, and require counties and municipalities, to adequately plan and provide efficient, environmentally acceptable resource recovery and management.
>
> (d) Require review of the design, and issue permits for the operation, of resource recovery and management facilities.
>
> (e) Promote the application of resource recovery systems which preserve and enhance the quality of air, water, and land resources.
>
> (f) Promote the recycling, reuse, or treatment of solid waste, in lieu of disposal of such wastes.

The Act created a Resource Recovery Council, and provided for the adoption of rules to implement the program.

Hence, Chapter 17-7, F.A.C., was promulgated, and Nineteen counties were designated as resource recovery areas. Each was required to develop a resource recovery and management program, including an implementation schedule, by July 1, 1979.

The designated counties were:

Alachua
Bay

Brevard
Broward
Dade
Duval
Escambia
Hillsborough
Lee
Leon
Manatee
Orange
Palm Beach
Pasco
Pinellas
Polk
Sarasota
Seminole
Volusia

The Department was assigned a number of responsibilities involving the implementation and enforcement of the act, in addition to the rulemaking responsibilities already mentioned.

- The Department was directed to provide technical assistance to counties, municipalities, and other persons;
- The Department was directed to promote the planning and application of recycling and resource recovery systems which preserve and enhance the quality of the air, water, and other natural resources of the state.
- Encourage recycling and resource recovery as an energy source.
- And assist in, and encourage, the development within the state of industries and commercial enterprises which are based upon resource recovery, recycling, and reuse of solid waste.

IV. Permitting

At the present time, there are essentially 2 ways to go about getting a permit from the Department for a waste-to-energy facility.

A. Power Plant Siting.

The first method I will discuss will be referred to as the Power Plant Siting Act.

Enacted in 1973, the PPSA is an attempt to reconcile environmental concerns with industrial progress.

At the time of the PPS Act's enactment, the 1973 oil embargo was tightening and a rapid conversion to non-petroleum based fuels was a national priority. The PPSA streamlined the lengthy and expensive proceedings previously required for site certification by preempting local government actions, and consolidating the approval of most state agencies into a single license.

The PPSA attempts to balance energy needs against their potential environmental impact to insure that the location and operation of new power plants will have only minimal adverse impacts on the environment.

Resource Recovery Facilities which will generate 50 Megawatts or more of electricity are required to undergo certification pursuant to the PPSA, but a facility generating less than 50MW may elect certification pursuant to the Act.

The certification of a resource recovery facility under the PPSA involves 5 steps:

1. The initial filing of the application and the $25,000 fee.
2. The land use hearing.
3. The need determination hearing.
4. The certification hearing.
5. The final Siting Board hearing.

At the initial filing, applications are submitted to the Department accompanied by a mandatory fee of $25,000. The fee is intended to cover both the administrative costs and expenses incurred by the Department for verification studies.

The Department then forwards copies of the application to the Public Service Commission, the Department of Community Affairs, the appropriate water management district, and any other affected state agency. A copy is also sent to the Division of Administrative Hearings, to request the assignment of a Hearing Officer.

If any third party intervenes, they also are provided with a copy of the application.

Upon receipt of the forwarded copy of the application, the PSC undertakes the preparation of a report determining whether the proposed facility is needed. Concurrently, the DCA is evaluating the application for compatibility with the State Comprehensive Plan. The Water Management District and other relevant agencies also prepare their reports, all of which are submitted to the Department prior to the certification hearing.

A land use hearing is held prior to the certification hearing, the sole purpose of which is to determine whether the proposed plant is consistent and in compliance with existing zoning ordinances. Following the land use hearing, the Hearing Officer issues a Recommended Order to the Siting Board, for final determination of the land use aspects. Should the siting board find the proposed site inconsistent with existing zoning, the applicant would need to apply to local authorities for a zoning change. If local authorities deny the petition, the applicant could seek a variance from the Siting Board.

Due to the fact that resource recovery facilities are usually proposed by local governmental units, the reality of the situation often is that the local government has made sure that the proposed site is properly zoned and is consistent with local zoning ordinances.

The Public Service Commission acts independently on the applicants determination of need. In reaching its conclusion, the PSC considers energy demand, cost, reliability, and any other factors, such as conservation efforts, which might mitigate energy demand. The PSC's determination of need is binding upon both the Hearing Officer and the Siting Board.

Statutory parties at the certification hearing include the applicant, the Department, the PSC, the DCA, the WMD. Any affected county, municipality, agency or other persons having substantial interests may intervene up to 15 days prior to the certification hearing by filing a notice of intent to intervene with the hearing officer.

Thirty days prior to the certification hearing, the Department will file its report, with a compilation of all the studies and reports required by statute, and which also includes the proposed Conditions of Certification which, if imposed on the applicant, provide the Department with reasonable assurances that the proposed facility will not cause or contribute to pollution of the state's air or waters in violation of state standards and regulations.

At the Certification Hearing, evidence and testimony will be adduced to support each party's position. There is also an opportunity for non-party individuals to submit oral or written testimony.

Based on the evidence obtained at the certification hearing, the Hearing Officer will then file a Recommended Order with the Siting Board. The Recommended Order includes findings of fact, Conclusions of Law, and a recommendation. The Siting Board will either affirm or deny the hearing officer's recommendation, or modify the recommendation.

Even after final certification, certification orders may be modified, revoked, or suspended. Supplemental applications requesting additional generating capacity can also be handled expeditiously.

As involved as it sounds, its possible for a facility to be certified within fourteen month's of initial application.

Balance that process against the alternative: a facility which will generate less than 50 MW can forego PPSA and obtain individual permits for each aspect of the facility which the Department has regulatory authority over. This would vary from facility to facility, but could conceivably include air construction, air operation, dredge and fill, wastewater treatment disposal, solid waste disposal, well construction, landfill construction and operation permits. Given the Chapter 120, Florida Statutes timeclock, permits must be issued 90 days after a complete application is received. Certainly 3 months is considerably shorter than 14 months, but when you consider the number of permits which may be required for a facility, and when you consider the potential for delay due to intervention by substantially affected persons who may challenge each permit the Department intends to issue, it's understandable why so many resource recovery facilities which have been permitted in Florida have opted for the PPSA certification process.

Future Trends

My initial comments should have made it clear that in Florida, resource recovery-waste-to-energy facilities are here to stay, and expected to increase in number.

There is some dissatisfaction within the Department of certifying these facilities under the PPSA due to the opinion that they cannot be adequately studied due to the relatively short-time frame for staff review of each facility. There is also some concern that the air emissions, which vary in concentration and amounts from day to day at each facility due to the variable nature of the fuel, cannot be safely predicted or controlled.

In recent months, the Department has been fighting with 2 counties over what consititutes Best Available Control Technology. As you may know, a BACT determination is required whenever a facility will emit over 100 tons of a regulated pollutant.

The BACT analysis includes a review of:

1. EPA determination of BACT or any emission limitation contained in NSPS or NESHAPS.
2. Scientific, engineering, and technical material and any other information avialable to the Department.
3. Emission limiting standards or BACT determinations of other states.
4. And an analysis of the social and economic impact of the control technology.

It is the 4th area of consideration which is the focus of the controversy between the Department and 2 counties presently undergoing certification. Both counties contend that it would add between $13 and $14 dollars to the tipping fee. As you know, the tipping fee is the cost of emptying one load of garbage at the RRF.

The Department counters that figure with its own statistics and information which suggest a more reasonable figure of $4 to $6.

As the entire BACT determination is a weighing process, the Department further contends that the cost of providing fine particulate control and acid gas control is necessary to protect the public health and welfare.

No resolution of this issue has yet been reached, but I can assure you that the Department will continue to fight for fine particulate and acid gas control until, ultimately, the Department's BACT is incorporated into the Conditions of Certification for one of these facilities.

I am available to attempt to answer any questions you may have. Thank you for your attention.

MASS-BURN AND REFUSE-DERIVED FUEL: INDUSTRY POINT OF VIEW

Daniel T. Skizim
American Ref-fuel
Houston, Texas

I'm not going to talk about RDF or refuse-derived fuel. My company is a mass-burn technology company. We have license from the system developer in West Germany for a mass-burn system. I can say, however, on an industry-wide basis there are certainly competent firms out there that espouse RDF as a way to dispose of waste and produce a useful material, energy.

I brought a film with me that describes the technology. It says everything that I could say to you standing here and it does one other thing, it shows you what a plant looks like. It shows you a plant operating if you've never seen one operating. I think it's useful to see it. The first five minutes of the film are a bit of a sales pitch on who we are as a company and I think that's important to a degree. If you're not interested, then feel free to take five. It's about five minutes in the front of the film. It's about a 15 minute film, but it's important to know who the companies are behind the technologies.

We are on an industry-wide basis, and I think I can speak for the industry in this type of forum, competent companies, capable, with a great commitment to the industry, the technology, and the environment. We have the resources to make these projects work well for your community or county and they do work well. I just want to leave you with that note and tell you that I think it is important to find out a little bit about who you're working with, that these projects are typically very long term, at a minimum a 20 year contractual commitment. That's a career for a lot of people. It's a long time and it's you, the people, that will have to live with those commitments. Politicians will change. They will go away and reappear and new ones will appear. But the people that live with that commitment have to work with the contractor, the vendor for over 20 years, some of this is up to 35 years. So, you should be comfortable and know as much as you can about the company that has the technology and might be providing the disposal service in your community. So, with that note can we start the film, please.

The projects that we get involved with involve zero public money other than the fee that is paid for the disposal service like everyone pays right now when their garbage is picked up off the curb. The moneys that are provided for the construction come from private investors who are willing to put the money up at some small risk, a good risk for them, and they will see a fair return for that investment. That's the source of the funds, plus the company's capital. So there's really zero public moneys involved here unless the public entity developing a project wants to make it a public ownership project. There's one right down on I-75 in the Tampa area, Hillsborough County, which is a publically owned project, I believe.

However, these projects really are public/private interfaces. It's a partnership of the public sector and the private sector that developed these projects. Without one, the other simply is not going to make the project in probably 99 percent of the cases that one would look at. There are rare instances of privately developed projects. They take a long time to develop and typically the area in which they might be located or developed, the community, will simply be standing in line with the rest of the customers for disposal capacity. So, it certainly is within the public's interest to be a partner in developing these projects.

I think regardless of the system developer all of these projects or plants typically look similar. There's a tipping hole where the trucks enter. There's a bunker for the storage of the refuse or the fuel. From that point on, you have the heart of the system. The black box, the combustion unit, the grate system which is unique to each vendor but it does basically the same thing. Everyone does the same job. It's combustion. There's no magic about it. It looks a little bit different than others. Everyone's got their own ideas about how to make it work the best of all. We think we have the best one. This grate in particular which is made up of circular segments is really the only large scale system that was developed solely to burn municipal trash. The others are simply adaptations of coal-burning grate systems.

From that point on, it's a power plant. It has the same equipment, probably higher standards than power plants. We can't turn around and ask for rate increases because there might be a problem. We have contractual commitments that run the life of the contract which I said is typically going to be 20 years on the service of these plants. So, we will typically design these facilities and inspect equipment to higher standards than power plants do. We need to know that they're going to work 20 years or 30 years for the life of the contract.

We typically will guarantee the operating costs. If it doesn't operate the way we think it will be then the company ends up paying. The stockholders don't like that.

That's really all I have.

CLEAN COMBUSTION TECHNOLOGY

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ABSTRACT

The background of the work which led to the formation in 1985 of the University of Florida-Sunland Training Center Clean Combustion Technology Laboratory (CCTL) is described. This program is now using boiler No. 3, a 535 HP watertube boiler, for experiments on the clean and efficient combustion of coal water gas (CWG) in an industrial boiler designed for oil. After successful demonstrations of this minimal cost oil boiler retrofit the objectives of the program have been expanded to also utilize boiler No. 4, a 450 HP watertube oil boiler, and boiler, No. 1 a 300 HP firetube gas boiler, in a broader clean combustion technology program. The expanded program will incorporate a used incinerator to serve (A) the needs of Sunland Training Center for waste reduction and energy recovery and (B) to serve as a research, development and demonstration (RD&D) incinerator to test advanced techniques in (1) source reduction, (2) recycling, (3) energy recovery (4) hot gas clean up, (5) emission reduction and (6) combustion product disposal. Emerging clean coal technologies are used as models of techniques to minimize harmful emissions from solid waste, wood and sludge combustion. With the help of other University of Florida and community resources the UF-STC-CCTL can serve as a leader in the RD&D of clean combustion technologies.

BACKGROUND

In 1979 - The United States experienced three energy shocks: (1) the 3 Mile Island accident (2) the IRAN revolution (3) the OPEC Cartel's doubling of the price of oil. That same year ICAAS, an interdisciplinary center established in 1970 to address air pollution problems, was awarded funds to study the impact of increased coal use in Florida (IICUF). At that time Florida lagged only California and New York in the use of oil in electricity generation and had a large number of relatively new oil boilers. Over 30 faculty members and students from all segments of U.F. participated in this study. Our conclusion in late 1980 [1,2] was that we must decrease our oil imports by conservation and greater reliance on our domestic coal supplies, burned in environmentally acceptable fashions.

Late in 1980 in connection with a fuel cost problem [3] I heard reports that our reserves of domestic natural gas were not as bad as official government policy had assumed. Since an examination of the literature [4] gave substance to this report, I initiated a personal research and development program on using gas to assist the clean and efficient burning of coal in boilers designed for oil [5-20]. During the course of our work we also

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concluded that gas could also assist the burning of wood, wastes, sludge and other potential domestic energy sources [5-18]. These ideas did not get friendly receptions. By advocating using some gas to make coal burn cleanly and efficiently in oil boilers we apparently violated conventional wisdom and governmental policy which was to use coal to make oil and gas (our synthetics fuel program). In addition by advocating burning gas-coal blends we were caught in the cross fire of fuel wars.

Despite many rejections of our requests for research funds we completed a number of scientific and engineering studies on the natural gas-solids combustion [5-20] and reached the conclusion that there are synergisms (1+2=4) which can be achieved in gas-solids combustion [14].

During these six years of work towards burning coal cleanly and efficiently I have followed other efforts with the same objectives and have participated in a study of this very topic as a member of the National Coal Council. The general framework which has emerged in the intense search for Clean Coal Technologies are also applicable to other clean burning technologies, including wood, solid waste, sludge and other potential domestic sources of energy which might replace imported oil.

The Clean Coal Technology framework divides itself into (1) Precombustion (2) Combustion and (3). Post-combustion measures. Included in the precombustion measures are coal cleaning by physical, chemical or biological techniques to reduce sulfur or ash which cause harmful emissions or inefficient burning. The combustion measures include arrangements which minimize the generation of NOx and help in the capture of SO_2. The post combustion measures include wet scrubbing, dry scrubbing, the use of advanced bag houses, cyclones or precipitators to capture fly ash, sulfur oxides and other harmful products of combustion. Table 1 is a list of evolving clean coal technologies for the purposes of retrofitting and converting industrial oil boilers while meeting new source performance standards (NSPS) [21,22]. Also included in Table 1 are some proposed combination options, a classification scheme as to the status of each option and an estimate of when each option can be reduced to practice.

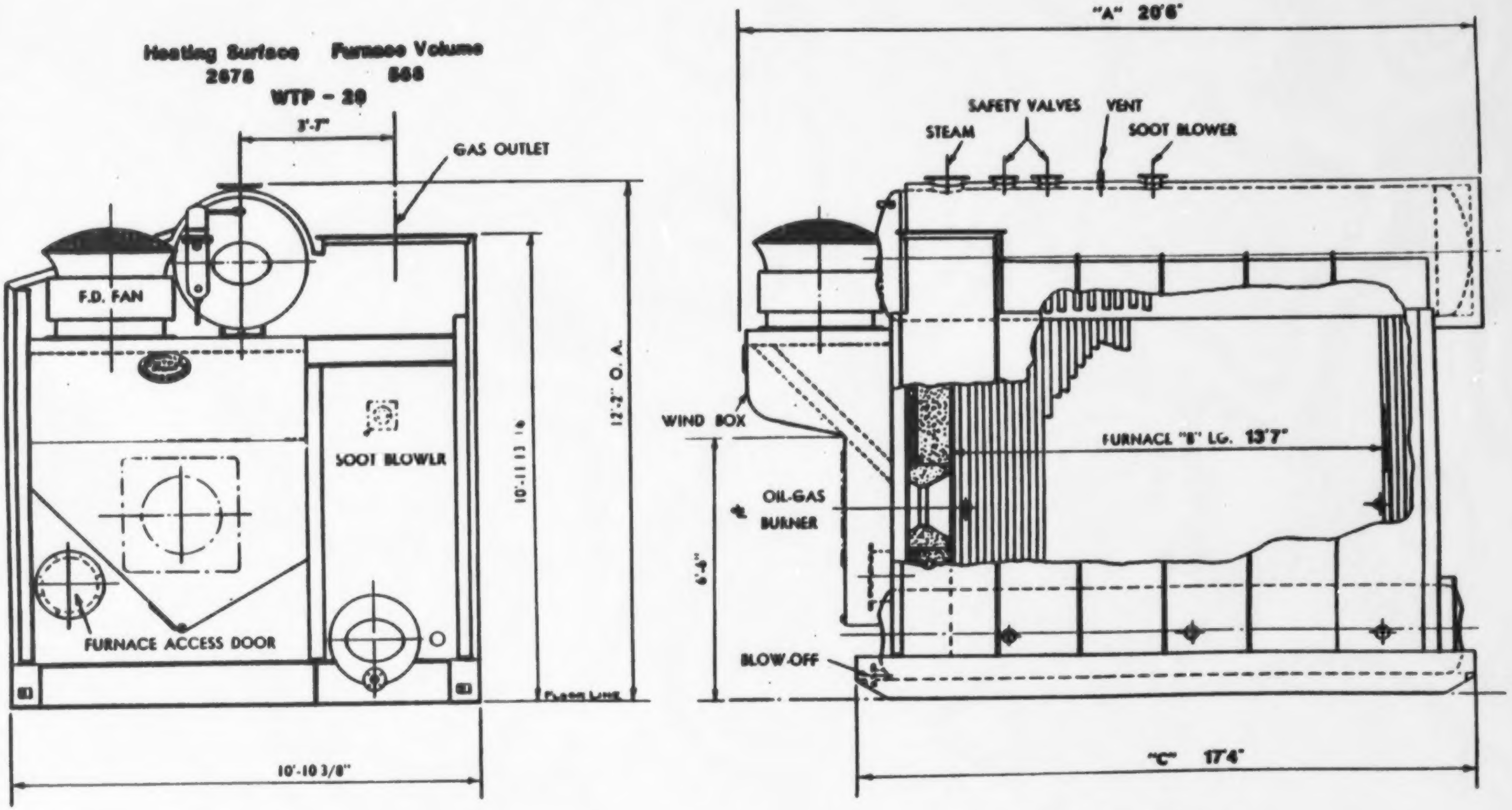
The opportunity to demonstrate potential synergisms in an industrial size water tube oil boiler came in 1985 with industrial and university funding and with the assignment to our program of the 535 HP watertube boiler at the Sunland Training Center which is approximately 4 miles from campus. Figure 1 is a schematic diagram of this boiler. Our modifications of the STC boiler to serve as quantitative calorimeter and our results to date have been reported at a number of technical conferences [18-20]. In addition to our experimental work we have devoted considerable attention to modeling the pyrolysis and combustion of blended fuel. Figure 2A Illustrates a proposed unit of coal in a macromolecular ash free coal network which can serve as a

TABLE 1
INDUSTRIAL OIL BOILER RETROFIT [21, 22]

A. PRE-COMBUSTION		
1. Coal Selection	C	1986
2. Physical Cleaning	C	1986
3. Chemical Cleaning	P	1995
4. Biological Cleaning	P	1995
B. COMBUSTION/CONVERSION		
1. Micronized Coal	P	1990
2. Coal-Water Slurry	P	1990
3. Coal-Water-Gas	P	1987
4. Two stage Slagging Combustion	P	1992
5. Two stage dry Combustion	P	1988
6. Sorbent Injection	P	1992
7. Low NOx Combustion	D	1988
8. Sel. Noncatalytic Red. of NOx	D	1990
8. Atmospheric FBC	D	1990
9. Pressurized FBC	P	1992
10. Gasification Combined Cycle	D	1988
11. Gasification Fuel Cell	L	1998
C. POST-COMBUSTION		
1. Conventional Wet FGD	C	1986
2. Spray Dry FGD	C	1986
3. Advanced Wet FGD	D	1990
4. Dry Injection FGD	P	1990
5. Combined SOx/NOx Removal	P	1995
6. Sel. Catalytic Red. of NOx	D	1990
7. Advanced Baghouse	P	1988
8. Advanced Cyclones	L	1990
9. Advanced Precipitators	L	1990
D. COMBINATIONS		
1. B5 + B6 + C4	I	1990
2. B6 + C3	I	1990
3. C3 + C6	I	1990
4. A1 + A2 + B3 + C2 + C7	I	1989
5. A1 + A2 + B3 + B5 + B6 + C2 + C7	I	1989

C Commercial, D demonstrated, P Pilot Plant

L Laboratory; I Idea/Concept.


Heating Surface
2678
Furnace Volume
568
WTP - 20
3'-7"
GAS OUTLET
F.D. FAN
SOOT BLOWER
FURNACE ACCESS DOOR
10'-11 13/16
12'-2" O. A.
FLOOR LINE
10'-10 3/8"
"A" 20'6"
SAFETY VALVES
VENT
STEAM
SOOT BLOWER
WIND BOX
FURNACE "B" LG. 13'7"
OIL-GAS
BURNER
6'-6"
BLOW-OFF
"C" 17'4"

FRONT ELEVATION

SECTIONAL SIDE ELEVATION

Fig. 1. Sunland Training Center WTP-20 water tube boiler (No. 3) manufactured by Struthers-Well in 1954.

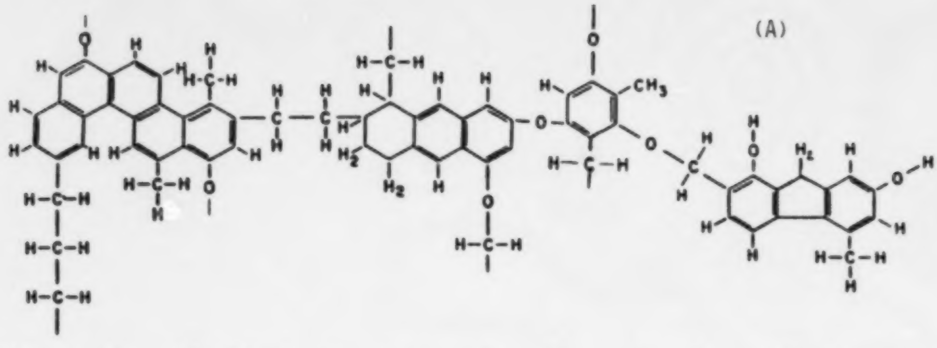


Figure 2A. Idealized structure of coal unit for inclusion in a macromolecular network. The unit shown has the formula $C_{68}H_{56}O_8$ and is ash, sulfur and nitrogen free (from [20]).

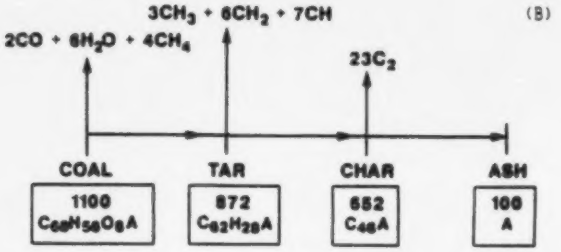

(B)
3CH₃ + 6CH₂ + 7CH
2CO + 6H₂O + 4CH₄
23C₂
COAL
TAR
CHAR
ASH
1100
C₆₈H₅₆O₈A
872
C₆₂H₂₈A
652
C₄₆A
100
A

Figure 2B. Simplified model of pyrolysis of a unit in a macromolecular coal network (from [20]).

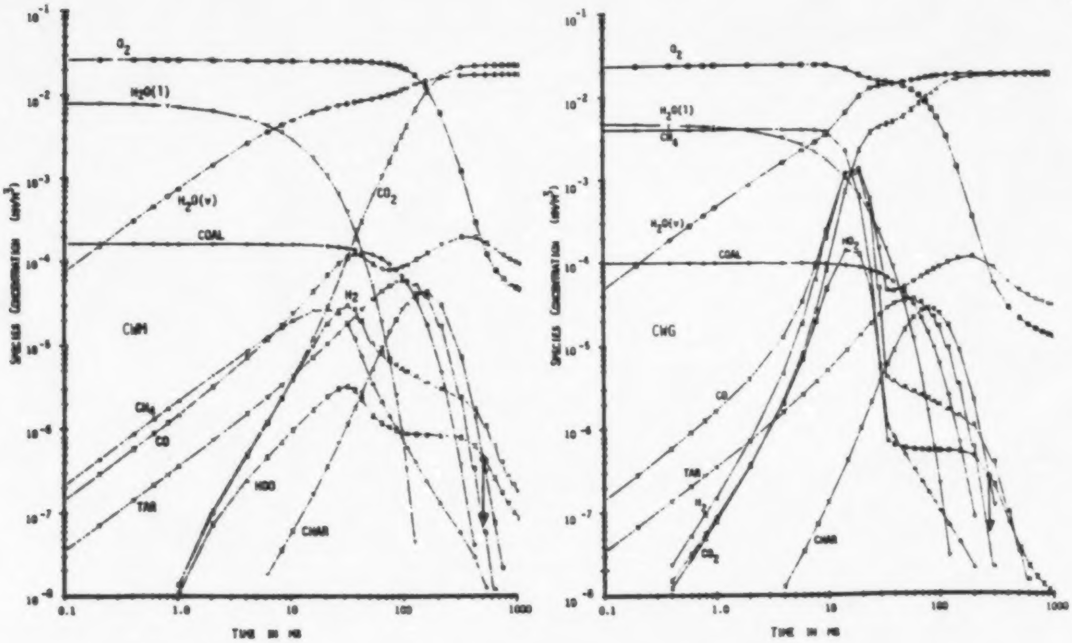


Figure 3. Major concentrations vs time according to coal pyrolysis model of Figures 2A and 2B and gas phase kinetics. The 1% char burnout point are shown by the arrows (A) for stoichiometric CWM (B) for stoichiometric CWG [20].

starting point in our pyrolysis modeling. Figure 2B illustrates a schematic model for the breakdown of such a unit in high temperature pyrolysis. This model has been quite successful in fitting data taken at MIT [23] on mass loss vs time and temperature. One might conjecture that a similar model might be applicable to the pyrolysis and combustion of organic waste materials. Figure 3A and Figure 3B illustrate the major species concentration vs time obtained in a kinetic calculation of coal water mixture (CWM) and coal water gas (CWG) combustion. The burnout time of CWG in this case turns out to be about 1/2 the burnout time of CWM. This would be very useful in achieving high percentage carbon burnout in minimal cost retrofits of industrial oil boilers. A summary of the major conclusions of our CWG work to date are listed in Table 2.

While the University of Florida was alone in gas-coal blending in 1980, programs have recently been established in Ohio, New York California, Pennsylvania and Louisiana [24-28]. Let us now turn our attention to waste combustion and take advantage of the fact that many of the techniques and concepts in emerging clean coal technologies should also be applicable to the clean combustion of waste with energy recovery.

WASTE COMBUSTION

One of the major problems of waste combustion is the highly variable heating value of waste which is largely a reflection of the highly variable water content of waste. Table 3 gives a frequently used overall waste classification system. A detailed listing of the heating value, moisture contents and other information on components wastes as received at a typical collection site is given by Niessen [29]. Figure 4A shows the hydrogen/carbon atom ratios of these waste components along with the H/C values of typical solid, liquid and gaseous hydrocarbon fuels. Figure 4B gives the heating values of these fuels. Figure 4C gives the moisture content (by percentages) of the typical waste components. One sees that many of the components of a typical waste stream have excellent fuel values and could, with a properly designed incinerator, also serve as an alternative to oil. However we must recognize that waste incinerators have more difficult requirements than coal, oil or gas boilers whose designs have been optimized for rather narrow ranges of fuel qualities.

In emerging clean coal technologies the need to retrofit oil boilers to accommodate a broader range of fuels is now receiving considerable attention. In 1973 when the first oil shock came, it was thought to be impractical to convert an oil designed boiler to coal. Indeed this issue came up in 73-75 in Gainesville [30] when the Regional Utility Board having ordered an oil boiler was forced to go to coal as a primary fuel by Federal order. We paid a heavy price in money and time to change

TABLE 2 CONCLUSIONS OF CWG - STUDIES TO DATE

(1) The conventional wisdom of the late 70's embodied in the multibillion dollar Synthetics Fuel program did not properly consider the Second Law of Thermodynamics.

(2) CWG is a user friendly fuel which can be burned in a boiler designed for oil with minimal retrofit costs and minimal derating.

(3) Many of the advances emerging from our Clean Coal Technology Program should be applicable to a more general Clean Combustion Technology Program, including waste combustion.

(4) Programs using gas assist for cleaner and more efficient combustion of coal in New York, Ohio, California, Pennsylvania, and Louisiana confirm the basic soundness of the original University of Florida gas-coal program.

(5) Now that OPEC oil prices are back to pre 1979 levels it will take extra cooperation between the gas, coal, and boiler industries and the government to reestablish an impetus to reduce oil imports and acid forming emissions.

Table 3

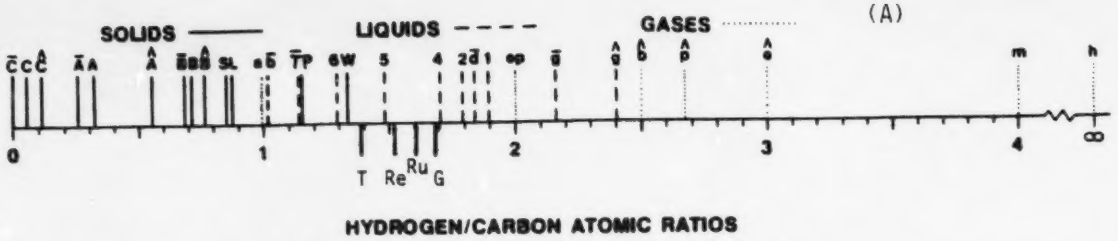
TYPE		WASTE CLASSIFICATION	Moisture Content %	Incombustibles %	Heating Value BTU/lb.	Density Lbs./ft
0	T	**TRASH**- A mixture of highly combustible waste including 10% plastics.	10	5	8500	8-10
1	Ru	**RUBBISH**- A mixture of Combustible waste, contains up to 20% by weight of Cafeteria waste.	25	10	6500	8-10
2	Re	**REFUSE**- A mixture of rubbish and garbage, common to apartments.	50	7	4300	15-20
3	G	**GARBAGE**- Consisting of animal and vegetable wastes from cafeteria.	70	5	2500	30-35
4	H	**HUMAN AND ANIMAL REMAINS**- Consisting of carcasses organs and solid organic wastes from hospitals, laboratories, and animal pounds.	85	5	1000	45-55

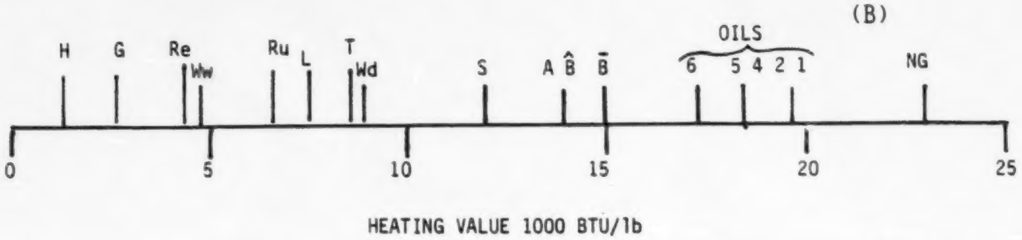
HAZARDOUS WASTES

1) HALOGENATED COMPOUNDS - Plastics, (a) Dioxins (PCDD) (b) Furans (PCDF) and (c) Polychlorinated Biphenyls (PCB's)

2) INFECTIOUS WASTE - Microorganisms

3) PATHOLOGICAL WASTE - Pharmaceuticals





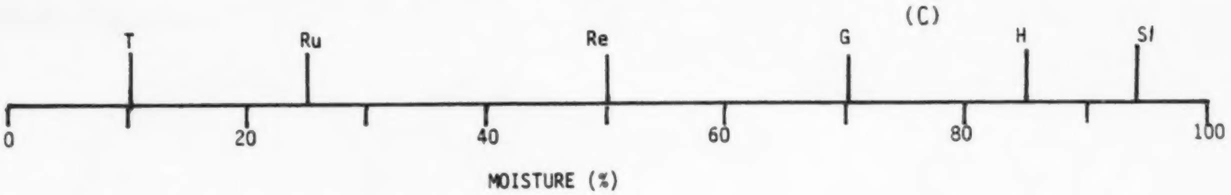


Figure 4A. Hydrogen/Carbon atomic ratios for various solid, liquid and gaseous hydrocarbons. The symbols denote the following: $\bar{C}$ - Carbon, C - Petroleum coke, $\hat{C}$ - Coal coke, $\bar{A}$ - Meta anthracite, A - Anthracite, $\hat{A}$ - Semianthracite, $\bar{B}$ - Low volatile bituminous, B - Medium volatile bituminous, $\hat{B}$ - High volatile bituminous, S - Subbituminous, L - Lignite, a - Acetylene, $\bar{b}$ - Benzene, $\bar{T}$ - Toluene, P - Peat, 6 - No. 6 oil, W - Wood, 5 - No. 5 oil, 4 - No. 4 oil, 2 - No. 2 oil, d - Diesel oil, 1 - No. 1 oil, e - Ethylene, $\bar{g}$ - Gasoline, p - Propylene, $\hat{g}$ - Natural gasoline, $\hat{b}$ - Butane, $\hat{p}$ - Propane, $\hat{e}$ - Ethane, m - Methane, h - Hydrogen, T -Trash, Re - Refuse, G - Garbage. These are representative. Actual hydrocarbons liquids and solids have a range of H/C ratios.

Figure 4B. Heating value of various fuels in 1000 BTU/lb. The symbols denote the following: H - Human and animal remains, G - Garbage, Re - Refuse, Ww - Wet wood, Ru - Rubbish, L - Lignite, T - Trash, Wd - Dry wood, S - Subbituminous, A - Anthracite, $\hat{B}$ - High volatile bituminous, $\bar{B}$ - Low volatile bituminous, 6 - No. 6 oil, 5 - No. 5 oil, 4 - No. 4 oil, 2 - No. 2 oil, 1 - No. 1 oil, NG - Natural gas.

Figure 4C. Moisture content of various fuels in percentage. The symbols denote the following: T - Trash, Ru - Rubbish, Re - Refuse, G - Garbage, H - Human and animal remains, Sl - Sludge.

the design and construction of the Deerhaven II generator from oil to coal because the original oil designed boiler was too specialized. In energy recovery incineration technology the furnace at the outset must be designed to accommodate a wide range of fuel heating values and qualities.

Among the best of the current incinerators are the so called starved air systems [31,32]. A standard starved air (C-760 Consumate Systems Inc) hospital incinerator with various forms of gas assist is illustrated in Figure 5. The wide range of waste heating values and the varying demands of hospitals for steam and heat favor the use of gas assist in several forms. For example natural gas burners can be installed in (1) the primary incinerator chamber (2) the secondary afterburning chamber and (3) the heat recovery boiler. The burner in the primary chamber is mainly used for the start up and ignition of the waste. The gas burner in the secondary or afterburning chamber serves to clear the emissions from unburned hydrocarbons and particulates. The gas burner in the boiler is fired when needed to enhance steam output and also for further flue gas clearing. Also shown in Fig. 5 is a hot gas cyclone clean up system to expose the gaseous and particulate waste stream to very high temperatures. A modern bag house caustic scrubber combination is used to filter all the remaining small particles from the stack and neutralized the hydrochloric acid formed from the combustion of halogenated plastics.

Batch loaded community and hospital incinerator/energy recovery systems using gas assist were developed in the early 70's. More recently, community incinerator modules have been developed with continuous processing of waste. In such systems a skid steer tractor pushes the waste into an automatic loader which injects the waste into the primary combustion-gas production chamber where transfer rams move the material slowly through the system. The high temperature environment in the gas production chamber is provided with a controlled quantity of air so that gases emitted from the incineration process are not burned in this chamber but fed to the upper or pollution control chamber. Here the gases are mixed with air and controlled to maintain a proper air fuel ratio and temperature for entrance into the boiler where steam is produced. Such continuous incinerators pass the inert material from the primary combustion process in the form of ash into a wet sump from which it is conveyed into a closed bottom container and hauled to a landfill.

Continuously operating incinerators run constantly and have better operating systems. Standard modules [32] have waste processing capabilities from about 25 tons per day and in simple combinations can handle 100 - 400 tons per day. Gas assist can provide additional environmental and operational benefits. A refuse separation and recycling program can be valuable in increasing the efficiency of refuse incineration and in energy recovery. However, it takes a very conservation minded community to make refuse separations and recycling work. Hanson et al.

[33] describe a number of technological innovations including co-combustion of densified refuse derived fuel (dRDF) with coal which help in refuse recycling and improvement in waste combustion.

There have been many studies of waste incineration [34-39] including feasibility studies of sludge/refuse co-combustion. However, Glen Cove, N.Y. has a fully commercial sludge/refuse facility that cogenerates 2.5 MW [40]. The plant has two combustion channels each rated at 125 tons/day with 10:1 feed rates of refuse to sludge. The HHV of the mix is about 4000 BTU/lb. Centrifuging concentrates the sewage solids from 5% to 20% solids. Positive displacement progressive cavity pumps deliver sludge to the refuse feed hopper of each furnace. The sludge is fed to the back side of each charging hopper and uniformly deposited into the refuse. The fuel mixture from the storage pit and sludge holding tank are fed to two stoker fired refractory furnaces. These are fired at 1700°F without auxiliary fuel generating over 34,000 lb/hr of 600-psig saturated steam in a dual-drum vertical tube convection boiler. Waterwall loops located on each furnace along the stoker line add 10% to the steaming capacity of the boiler. The steam feeds a turbine generator producing about 2.5 MW. Half of the electric output is used by the plant.

The twin Glen Cove incinerators do not incorporate gas augmented afterburning chambers. These would provide added heat to the waste boiler when needed and help cleanse the final combustion gases. Such provisions would undoubtedly provide extra flexibility and better emissions control.

In sludge/refuse incinerators the higher heating value of the refuse is used to assist in the evaporation of sludge water. High performance sludge dewatering devices such as belt presses, filter presses and advanced centrifuges can alternatively be used [40-42]. Sludge incineration can probably be carried out in a similar fashion to the combustion of coal water slurry with natural gas assist. Thus natural gas can be extremely helpful in foreburning for flash evaporation of the residual water and rapid pyrolysis and ignition and afterburning for air pollution and odor control. The ash might also be useful as a fertilizer if industrial sludges are not incorporated into the waste stream.

Niessen [29] discusses direct flame afterburners systems for incinerators most of which use natural gas. He calls attention to the need for more attention to afterburner design not only for improved pollution control but also for improved heat recovery.

Table 4 summarizes our recommendations for clean waste combustion technologies in a manner which parallels Table 1 on clean coal technologies.

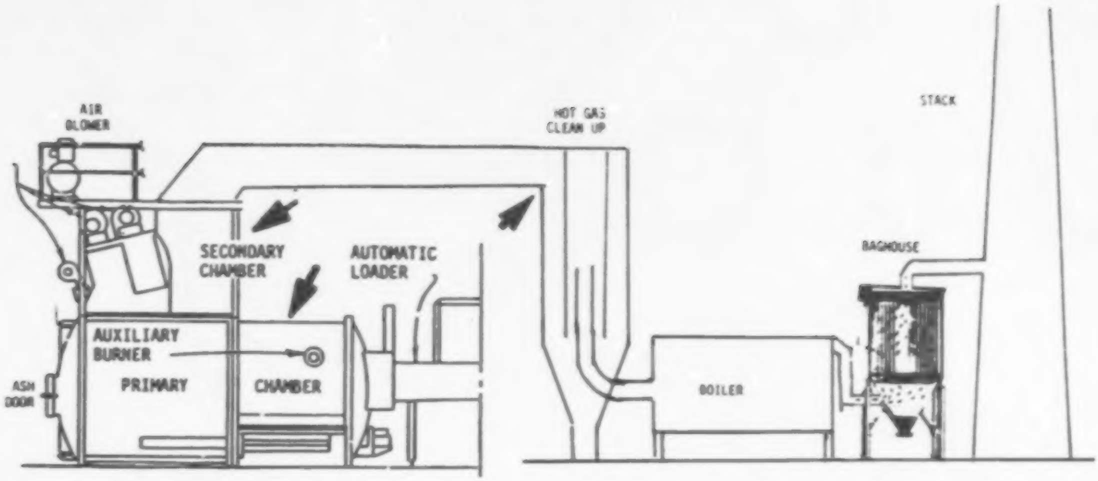

AIR
BLOWER
HOT GAS
CLEAN UP
STACK
SECONDARY
CHAMBER
AUTOMATIC
LOADER
BAGHOUSE
AUXILIARY
BURNER
ASH
DOOR
PRIMARY
CHAMBER
BOILER

Figure 5. Schematic diagram of starved air incinerator with secondary chamber, hot gas clean up, recovery boiler and bag house (caustic scrubber not shown).

TABLE 4 CLEAN WASTE COMBUSTION TECHNOLOGIES

PRE-COMBUSTION

(a) Label then ban use of hazardous compounds in every day waste stream
(b) Manufacture and use products to minimize waste
(c) Sort recoverables, recyclibles, compostibles, and feedstockibles
(d) Use processors, flailers, sorters, driers to improve burning qualities and reduce hazardous waste generation.

COMBUSTION

(a) Use gas-assist to compensate for fuel quality and hazardousness
(b) Use multistaging with high temperature stages
(c) Recover combustion energy
(d) Use combination techniques and air and gas staging

POST-COMBUSTION

(a) Hot gas clean up
(b) Advanced bag houses
(c) Advanced precipitators
(d) Use caustic scrubber to reduce acid emissions
(e) Use residuals where possible
(f) Properly landfill remainder

CONCLUSIONS

CLEAN BURNING WASTE TECHNOLOGIES are not yet perfected, more RD&D needed:

EMERGING CLEAN COAL TECHNOLOGIES can provide useful techniques.

ALACHUA COUNTY CAN LEAD RATHER THAN FOLLOW.

WOOD WASTES

Since 1973 a great deal of attention [43-47] has been given to the potential use of wood as an alternative to oil. These efforts considered both intentionally grown biomass and wood waste. Much of the R&D effort associated with the former program has declined with the dismantlement of the synfuel program and the recent oil glut. However urban and rural wood waste disposal remains a continuing environmental problem.

Mill residues ranging from large slabs, edgings and end trim, to stringy hog-wooded bark and fine sawdust are traditional sources of wood waste. Pulp and paper mills leave mountains of unused bark. With recently developed whole tree chippers a great variety of forest residues could serve not only as a source of energy but to foster timber stand improvement. It is estimated [47] that thinning 100,000 acres per year would yield the energy equivalent of 5 million barrels of oil per year.

Hardwoods typically have an average oven dry heating value of 8500 BTU/lb and their dry bark 8000 BTU/lb. Oven dry softwoods and their barks average about 8900 BTU/lb. At 50% moisture content 4250 BTU/lb may be taken as representative. Whole tree chips delivered at $20.00 a green ton at a combustion efficiency of 65% is equivalent to $3.60 per million BTU which is still a reasonable thermal price considering that waste disposal is accomplished at that same time.

Water content is a major variable in wood waste utilization and here again gas assist can serve as a useful co-fuel to accommodate the particular characteristic of any load in a heat recovery incinerator. The technology of hogged wood waste burning has advanced considerably in recent years. Gas assist for drying, pyrolysis and ignition and gas afterburning for emission reduction adds the extra degree of control needed to accommodate a large diversity of wood waste fuels. Rather than waste wood and consume landfill space, the time has come to use wood waste for our energy needs.

Nationally, waste wood from the forest industry such as tops and stumps, cull trees and non-merchantable species could supply about 10% of current energy use. In Florida with its large forest industry, waste wood could supply about 20% of current energy use. Gas assist in the initial and afterburning zones can help make this otherwise wasted resource into a valuable and environmentally acceptable fuel.

CONCLUSIONS

Great strides have been made in incineration technology over the past decade so that many of the gross air pollution problems of early incinerators have now been overcome. Nevertheless there are still significant uncertainties as to the residual risks due to the combustion products of some modern materials which enter community or hospital waste streams. These risks must, of course, be balance against those associated with alternative waste disposal methods such as the use of landfills, dumping at sea, recycling, composting etc. Comparative socio-economic costs of the various waste disposal alternatives must also be considered in making a final public policy choice. It is our view that on the balance the incineration option with energy and materials recovery will fare well with respect to other options. However it is important to resolve residual questions by carefully formulated and executed RD&D. The intensive efforts underway in the national Clean Coal Technology Program provides useful insights to advance clean combustion technologies in general. The University of Florida (UF) and the Sunland Training Center (STC) are thus extending the research, development and demonstration (RD&D) program of The Clean Combustion Technology Laboratory (CCTL) to include a program on Clean Waste Combustion. The Sunland Training Center, a division of the Florida Department of Health and Rehabilitative Services, is in Gainesville, Alachua County, Florida, four miles from the University of Florida campus.

In this program we will use either Boiler No. 4, a 450 HP water tube boiler, or Boiler No. 1, a 300 HP firetube boiler, or a smaller boiler of about 100 HP capacity for energy recovery. An advanced incineration system retrofitted to exceed the requirements of the Clean Air Act will handle 500 lb/hr of Sunland Training Center's wastes in an 8 hour shift. The system will use gas assist as needed depending upon the momentary heating value of the waste stream. It will also incorporate a hot gas clean up stage to break down all hazardous organic wastes, a bag house and finally an acid scrubber. It will also serve as a test incinerator for demonstrations carried out in the next year and for measurements of energy recovery and emissions levels when burning various substances. Thus stack gases will be sampled and analyzed by the most advanced analytical facilities available at the University of Florida and at the cooperating environmental firms in the Alachua County region. The experimental RD&D will be accompanied by a literature search on advanced incinerator systems throughout the world. In addition, theoretical and analysis efforts will be carried out to permit scaling the CCTL results to incinerators suitable for county or multi-county waste disposal. A pilot scale recycling and waste sorting program will be incorporated into the training program at Sunland. Advanced concepts on sorting waste components before burning which emerge from the N.E. Florida waste management study can be tested at the UF-STC-CCTL for later possible applications at the county or multicounty level. The general objective will be to use the many community resources available in the Gainesville region to advance the state of clean incineration for consideration as options in overall waste disposal studies.

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An Overview of The Burning Issues of Municipal and Hospital Waste Incineration.

by Jack D. Lauber PE,DAEE

Presented at the University of Florida, Gainesville Florida, March 1,1986,at "There is no Away"; Interdisciplinary Conference on Strategies for the Comprehensive Management of Domestic, Municipal,and Hazardous Wastes.

Introduction and Overview

We are now faced with a crisis in disposing of our municipal wastes; we generate about 150 million tons of garbage each year, and bury most of it in landfills. Our landfills are becoming toxic time bombs, often poisoning our precious ground waters.

Waste incineration previously was used by many municipalities, but older, polluting incinerators were generally eliminated over a decade ago, because many were violating air pollution control regulations.

Many municipal consultants are now recommending MSW incineration resource recovery systems that also recover substantial energy; much of this technology is based on European experience, which initially used electrostatic precipitators to only control particulate emissions.

Recent studies have indicated that MSW incinerators only equipped with ESP´s can emit significant quantities of acid gases, and toxic air contaminants such as heavy metals, dioxins and furans.

Some environmentalists do not believe that MSW incineration ever can be made safe and advocate waste recycling as an alternate. However, only a small fraction of our wastes can now be effectively, and economically recycled; plastic wastes, especially PVC types, cannot be realistically separated and recycled; and yet they may pose serious emission problems if improperly burned.

Proper, high combustion efficiency incineration can minimize trace organic emissions, such as dioxins; acid gas controls can also condense and remove dioxins and furans; and heavy metals, as proven in recent European tests. Thus BACT, best available control technology, that can meet California, and European state of the art air pollution control standards, can make MSW incineration a safe and effective waste disposal strategy.

What are Municipal Wastes Composed of?

We live in a complex society , therefore our wastes are heterogeneous mixtures of many things, food wastes, paper, metals, and complex plastic resins of many types, including PVC plastics, that contain chlorine . Waste batteries and electrical components can add heavy metals, ie; cadmium, lead, mercury, etc. and even PCB´s to MSW . Discarded household cleaners, pharmaceutical products, garden chemicals, and pesticides, further add hazardous components to our wastes. Photographic product wastes,also contain complex chemicals and toxic metals.

Studies of municipal waste sources have revealed that a large fraction of hazardous components in MSW come from domestic sources. Although there are prohibitions against disposing hazardous industrial and hospital wastes with MSW, this routinely occurs, and is difficult to enforce against.

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Proper, high combustion efficiency incineration can minimize trace organic emissions, such as dioxins; acid gas controls can also condense and remove dioxins and furans; and heavy metals, as proven in recent European tests. Thus BACT, best available control technology, that can meet California, and European state of the art air pollution control standards, can make MSW incineration a safe and effective waste disposal strategy.

What are Municipal Wastes Composed of?

We live in a complex society , therefore our wastes are heterogeneous mixtures of many things, food wastes, paper, metals, and complex plastic resins of many types, including PVC plastics, that contain chlorine . Waste batteries and electrical components can add heavy metals, ie; cadmium, lead, mercury, etc. and even PCB´s to MSW . Discarded household cleaners, pharmaceutical products, garden chemicals, and pesticides, further add hazardous components to our wastes. Photographic product wastes,also contain complex chemicals and toxic metals.

Studies of municipal waste sources have revealed that a large fraction of hazardous components in MSW come from domestic sources. Although there are prohibitions against disposing hazardous industrial and hospital wastes with MSW, this routinely occurs, and is difficult to enforce against.

Can We Effectively Recycle Our Municipal Wastes?

Waste recycling is an admirable goal, and we should encourage as much recycling as possible. However there are certain technological, and economic limitations to the recycling of MSW components.The Institute for Local Self Reliance of Washington D.C. studied waste recycling for the city of Philadelphia Pa. and estimated that about one third of this city's MSW could be recycled by various processes; however they also recommended that a refuse derived fuel be produced which could be burned in dedicated boilers, equipped with proper BACT air pollution controls.1

The most practical form of MSW recycling that now exists is precombustion separation of glass, metals, etc. which is practiced at Nashville and Gallatin Tenn. MSW disposal facilities; and is being planned for a New Haven Ct. MSW incineration project.2

Can Plastic Wastes be Recycled?

Some environmentalists advocate the recycling of plastics in MSW, to lessen the hazards of MSW incineration; by allegedly removing major sources of chlorine in MSW. Certain waste recycling processes exist in Europe that can separate and recycle light plastic film type materials, such as polyethylene and saran type plastic wastes. However because PVC plastic components are so heterogeneous and vary in molecular weight considerably, they cannot be practically separated from MSW; in addition, leading polymer experts have said that there are no prospects for being able to recycle most PVC in municipal wastes, because of it s thermosetting physical properties.3 Thus limited waste recycling and proper MSW or RDF incineration appear to be the most effective current MSW disposal alternatives.

What factors influence the Proper Combustion of Wastes?

Combustion has been known since our ancestors discovered fire; time, temperature and turbulence, the three T's of combustion , are the prime factors governing how well a fuel or waste can be burned. This may appear simple, but we still do not fully understand all the complex chemical reactions that can occur in fire. However there is much practical knowledge about the proper burning of various wastes, and the destruction of waste components.

The primary objective of waste incineration is to provide suitable oxygen and temperature to convert the combustible components into carbon dioxide and water vapor.

It is generally accepted in the scientific community that 1000 C or 1800F is a sufficiently high temperature to achieve 99.99% or greater destruction of the most difficult chlorinated compounds such as PCB's; dioxins , and furans, if sufficient oxygen is supplied and mixed properly with the combustible materials.4

The best proof of combustion effectiveness available today is the measurement of carbon monoxide (CO) emissions; which only has recently been applied to MSW incineration4. However, while there appears to be a general trend of low hydrocarbon and trace toxic emissions, such as dioxins, with low carbon monoxide emissions and high combustion efficiency; no exact relationship between these parameters appears to exist; because there are other more complex factors, that are not well understood. However authorities have generally concluded that high combustion efficiency operation(about 100 ppm CO) of MSW incinerators will minimize the emission of dioxins and other trace toxic organics, similar to the destruction of PCB's in hazardous waste incinerators and high efficiency boilers.5

Though combustion controls can prevent formation of excessive amounts of gaseous carbon monoxide and hydrocarbons, maintaining sufficient temperatures and oxygen and mixing conditions will probably not destroy all the dioxins, since absolute control over furnace conditions at all times is not yet demonstrated.6

An Overview of Waste Incineration Air Contaminants

Particulates

Particulates that can be emitted from MSW and other types of incinerators are small solid particles or aerosols that can range in size from less than one micrometer (micron) to hundreds of microns; consiting of carbon, silica, alumina, sulfates ,etc. combined with heavy metals, acids, trace organics , and other pollutants6.

Particulates have been shown to be harmful to human health;especially the ultra fine ,submicron particles, which often contain adsorbed toxic substances, such as heavy metals and organics.These very fine particles can reach the alveoli of our lungs, and are believed to be responsible for chronic health effects.6

The control of submicron particles is a very important aspect of waste incineration, because MSW incinerators typically generate particulates in two general size ranges,0.5 and 5 microns.4 It is generally recognized that ESP's have a window where control efficiency for 0.5 micron particles can drop considerably, about 5% or more, compared to fabric filters whose control efficiency is generally greater than 99% for sub micron particles.4,6.

Acid Gases

Acid gases are generated primarily from sulfur and chlorine in wastes; there are also other types of acids that can be formed in MSW, but they are minor compared to the primary sulfur and chlorine containing acid gases, where sulfur dioxide can be converted to sulfuric acid, and chlorine in waste forms hydrochloric acid, HCl.

There are three main concerns about acid gas emissions;localized acid gas corrosive and health effects, contribution to regional acid rain problems, and enhancement of the toxic effects of heavy metals.

Hydrochloric acid is very corrosive ,and in some cases HCl emissions from MSW incinerators have caused direct localized corrosive effects, as in the case of the Northwest Philadelphia incinerator where the emissions have allegedly impacted on a nearby electrical transmission line, causing severe corrosion.4 There is also documentation of similar acid attack on buildings in Europe4. HCL can also cause irritation to the eyes, and the respiratory system; and additional health effects from the inhalation of fine particles laden with such acids which are capable of lodging deep in the lungs6.

We are familiar with the problems of acid rain, which are generally caused by sulfuric and nitric acids, which form from power plant and automotive emissions; however HCL, while not emitted in as large quantities as SO2, is a much stronger acid; and highly corrosive HCl acid gas mists having 18-20% HCl content and a pH of 2, can form from MSW incinerator emissions.6.The State of New Jersey engaged a USEPA consultant to study this problem; they concluded that MSW incinerators may become major contributors to ambient acid gas levels, and recommended BACT controls to minimize the contribution of MSW incinerators to this regional acid rain problem, and to protect the general population from the localized effects of these gaseous emissions.5.

Toxicologists know that heavy metals, while toxic by themselves, are far more toxic in the presence of acid gases, since they become more soluble in body fluids. Thus the combination of Acid gases and heavy metals can result in enhanced synergistic health effects that are not well known.

With the levels of plastics in our waste streams increasing, many communities are approaching potential acid gas emission factors of about 10 lbs.of HCl per ton of waste, similar to European and Japanese waste levels.5. USEPA RCRA Hazardous waste regulations require that HCl be controlled by 99% or to 4 lbs.per hour; yet typical MSW incinerators can have as much as 50 times the HCl emissions than hazardous waste incinerators, and are uncontrolled in many cases; for example,a large 1500 ton per day MSW incinerator could emit more than 600 lbs.per hour of HCl acid gas emissions. Consequently there are many good reasons to require BACT acid gas controls for MSW incinerators.

Dioxins and Heavy Metal emissions

Polychlorinated dioxins and furans are regarded as some of the most toxic man made substances; dioxins have been reported to be 500 times more toxic than strychnine, and 10,000 times more potent than cyanide16; There is also a fear of a long term malignant effect, which has not been proven.16 Dioxins and furans are thought to be formed as a result of poor combustion, by complex reactions involving the pyrolysis and combustion of PVC plastics ,chlorophenols and benzenes;and lignin and chlorine, which are ubiquitous in municipal,wastes.6

Canadian experts have cited improper waste incineration as one of the largest sources of dioxins emitted into our environment.7 The Swedish government has placed a moratorium on the construction of new MSW incinerators, because of recent evidence of widespread dioxins in their environment; believed to be coming from existing waste incinerators, many of which lack proper controls. This Moratorium does not mean that Sweden has no faith in incineration technology, rather they are awaiting the evaluation of new BACT technology, and environmental standards.17.

While the poor combustion of MSW has significant potential to form dioxins, the improper combustion of hospital wastes for example , has a much greater dioxin/furan emission potential, because the plastic content of hospital wastes is about 5 times greater than MSW.7 Many experts believe that existing hospital waste incinerators, which are mainly poorly controlled, are emitting more toxic emissions than hazardous waste incinerators that comply with USEPA RCRA regulations.7.

There is much controversy concerning the formation of dioxins and furans in waste incineration,8 and whether efficient combustion can minimize dioxins and furans; and many theories exist. I shall briefly summarize what I believe to be true.

Summary of Key Dioxin/Furan Emission and Control Issues

1.Dioxins and furans are formed from the pyrolysis,and partial oxidation, of PVC , chlorophenols and benzenes etc.and by the primary reaction of nonchlorinated organics with chlorine, from both organic and inorganic halogens in waste; by comlex reactions which are not well understood.

2.I agree with Shaub that dioxins and their precursors can form on the grate bed of the combustion zone8; but they also can form later in post combustion zones , especially from continuing thermal reactions on incandescent particles.

3.Dioxins and furans exist in both vapor and on fine particles in MSW and hospital waste incinerator emissions, and may be present at levels up to 80% in the vapor phase of MSW incinerator emissions.5,7,9,10.

4.Dioxin and furans can be minimized by high combustion efficieny waste incineration.3,4,5,6,7,9,11,12.Recent studies by Cavallaro et al in Europe have shown dioxin reductions of greater than 99% with MSW incinerator afterburners operating, compared to the burners being shut off.12.

5.High combustion efficiency MSW incineration can result in acceptable, safe dioxin/furan emission levels; although it is uncertain whether such low levels can always be achieved by combustion alone, without supplementary controls. Recent tests of the Westchester Resource Recovery Facility have indicated very low dioxin/furan emissions, at greater than 99.9% combustion efficiency; with PCDD/PCDF emissions far less than the 500 ng/cm PCDD/PCDF emission level certified as safe by the US Army Surgeon General for the incineration of PCP coated wood in hazardous waste incinerators.13

6.Dioxins and furans behave like PCB´s and will condense onto fine particles at temperatures of 300F and less, for proper collection and removal by a fabric filtration system .4,6,7,9,10,11.Dr.A.Teller and I initially proposed this concept in 1983, based on studies of European MSW incinerator dioxin data.9 Recent Danish dry scrubber tests have confirmed greater than 99% dioxin/furan removal at about 120C, as we previously predicted. Hence efficient collection devices operated at temperatures in the 200-300F range should provide a "belt and suspenders" approach.This should be reassuring to people who do not have confidence in combustion technology.4.

7.Sulfur in wastes may inhibit the formation of dioxins, because of the Deacon reaction favoring HCl formation, instead of in-situ Chlorine, which is believed to react with precursors more readily than HCl, to form dioxins; this may explain why virtually no dioxins have been found in coal combustion emissions.14 The presence of in-situ chlorine in MSW and hospital waste incinerators, which is believed to be greater in excess air combustors, versus controlled air combustion systems, should be further evaluated as factors in dioxin formation in MSW and hospital waste incineration.

8.Dioxin and furan emissions from previously tested hazardous waste incinerators are generally an order of magnitude less than such emissions from MSW incinerators generally equipped with electrostatic precipitators.15 This may be because all hazardous waste incinerators are required to operate at high combustion efficiencies of 99.9% and have scrubbers to control acid gases, that also condense and remove dioxins; unlike many conventional MSW incinerators.

Heavy Metal Emissions

We previously discussed the comlexity of our wastes and the presence of heavy metals such as lead , cadmium, etc. from batteries and electrical scrap; which form toxic metal fumes when incinerated; some of these toxic metals, like arsenic and cadmium are also believed to be carcinogenic. Likewise, hospital wastes may also contain toxic, radioactive metallic compounds that are also present in fine, submicron particles in incinerator emissions. It is believed that heavy metal emissions can be highly variable, and may pose chronic, long term health effects; the enhanced toxic effects of heavy metals and acid gas emissions should be further studied.

Like dioxins, studies of heavy metal emissions have revealed that a reduction in the exhaust gas stream temperatures will result in increased condensation of these contaminants onto fine particles where they can be effectively removed by a fabric filter.5 Previous studies show that about 75% of heavy metals are concentrated on particles less than 2 microns; thus ESP's with their submicron window, will not be effective in controlling these contaminants.

Conclusion.What are Safe BACT Standards for MSW and Hospital Waste Incineration?

BACT is a confusing term; to most of us it should mean the best air cleaning technology; however USEPA BACT interpretations define BACT as 0.03 gr/scf; which are not the best standards ,and do not consider the problems of toxic, non criteria air contaminants. California requires 0.01 gr/scf overall for the control of particulates, and 0.008 gr/scf for particles less than 2 microns19. Several other states, such as Connecticut, New Jersey, and recently Florida, have specified BACT as close to LAER, lowest achievable emission rate, as 0.015 gr/scf for particulate emissions from MSW incinerators; New York State has proposed a similar,0.02 gr/scf emission standard for the N.Y.City area.

For acid gases, the states of California, New Jersey, Mass., Maine, Oregon, Utah, Michigan,and the City of New York6; and recently Florida have proposed acid gas controls for new waste to energy MSW incinerators, as BACT; similar to existng acid gas control requirements that have existed in Europe for many years 11.

The New York State Legislative Commission on Solid Wastes recently studied the state of the art of MSW resource recovery in Norway, Sweden, Denmark and Germany 11, and concluded that :

1."For waste to energy systems, the most significant improvements have come in the area of acid gas control technology."

2."There is promise that effective limitation of dioxins can be achieved through high quality dry scrubbing and fabric filtration technology".

3."All new facilities proposed for New York State should be required to control acid gas emissions to at least 90%; Particulate removal to less than 0.02gr/scf is a reasonable standard for all new plants to achieve; and fabric filtration and dry scrubbing technology would probably be needed to achieve these levels".

In addition to the above BACT recommendations, MSW incineration combustion efficiency should be maintained at 99.8% or greater on a daily average and at least 99.5% on a short term hourly basis.18

There are also many other proper MSW incineration design and operational factors that represent BACT, and can be incorporated into source permits; which can be found in the references; such as combustion zone temperatures, residence time, etc.4,5,11,18,19.

Hospital incinerators are generally not properly controlled, and should be regulated similar to hazardous waste incinerators; taking into account design and operational differences. However, proper controlled air , high combustion efficiency incinerators should be specified for hospital wastes, as certain states such as California now require. Hospital waste incinerators should also be equipped with appropriate air scrubbing systems to properly control dioxin/furan, heavy metal, radioacive, and acid gas emissions.20

The specification of proper BACT waste incineration and air pollution control technologies, can insure that all toxic air contaminants and acid gases will be adequately controlled; we must redefine The USEPA definition of BACT, to include acid gases and toxics as several progressive states have already done. There need no longer be a burning issue of toxic emissions from waste incineration.

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RISK ASSESSMENT OF DIOXIN EMISSIONS FROM MASS-BURN INCINERATORS

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It is generally accepted that polychlorinated dibenzo-p-dioxins (PCDDs or "dioxin") and polychlorinated dibenzofurans (PCDFs or "furans") pose the major human health threat from incinerators that burn unseparated trash. Thus, the acceptablity of a proposed mass-burn incinerator depends on the assessment of the risks due to these substances.

PCDDs and PCDFs are quite similar in their molecular structures and properties. PCDDs are molecules consisting of two six-membered carbon rings (benzene rings) joined through two oxygen atoms, with one to eight chlorine atoms attached to the rings. PCDFs are similar, except that the two rings are linked through a single oxygen atom.

PCDDs and PCDFs are each classified into eight groups (homologues) according to the number of chlorine atoms they contain. For example, those PCDDs with four chlorine atoms are known as tetrachlorinated dibenzo-p-dioxins, or TCDD. Within each such subgroup or homologue, individual forms (isomers) are designated by the numbered molecular positions that are occupied by the chlorine atoms. Thus, 2,3,7,8-TCDD signifies that this isomer -- the best-known individual substance in the family of PCDDs and PCDFs -- is a PCDD with four chlorine atoms in molecular positions 2, 3, 7, and 8. There are 75 PCDD isomers and 135 PCDF isomers.

Health Effects of PCDDs and PCDFs

Chiefly from experiments with laboratory animals, PCDDs and PCDFs are known as a group to exhibit a number of important biological effects, among them: acute toxicity (i.e., death shortly following exposure), increased incidence of cancer; depressed immunological response, neurological symptoms, and skin eruptions (Poland and Knutson, 1982). In assessing health effects at the levels of environmental exposure resulting from incinerator emissions, the main area of concern is increased cancer incidence. (Depressed immunological response may also be a concern. However, it is not as yet known what level of exposure causes this effect.) This concern arose originally when it was discovered that cancers occur in laboratory animals exposed to very low doses of 2,3,7,8-TCDD (Kociba *et al*.,1978). Since then it has been found that a mixture of two PCDD isomers in the hexa-chlorinated subgroup also causes cancer in laboratory animals (NTP, 1980).

Although laboratory experiments have only implicated these three individual PCDDs as cancer-producing agents, there is good reason to believe that many of the 210 individual PCDD and PCDF also have this capability. This information derives from experiments which suggest why PCDDs increase cancer incidence. These experiments show that many substances that occur in the environment induce cancer only after they have been chemically changed in the body of an exposed animal. They also show that PCDDs and PCDFs powerfully stimulate the enzymes that catalyze this change. Thus, it is thought that PCDDs and PCDFs increase the incidence of cancer by enhancing the conversion of environmental chemicals to active carcinogens (Poland *et al*., 1982; Pitot *et al*., 1980).

For these reasons, the ability of a given PCDD or PCDF to stimulate the AHH enzymes may be a good indication of its ability to increase cancer incidence. A considerable number of PCDD and PCDF isomers have now been tested in this way, and the results can be used to evaluate the cancer-enhancing activity of the different PCDD and PCDF homologues.

Evaluation of the relative cancer-enhancing potency of the various PCDD and PCDF homologues plays an important role in the assessment of health risks due to trash-burning incinerator emissions. Procedures have been devoloped which evaluate quantitatively the expected cancer-enhancing effect of particular PCDD and PCDF homologues relative to the effect of a standard isomer -- 2,3,7,8-TCDD. These procedures are designed to express the cancer-enhancing activity of a PCDD or PCDF isomer in terms of an amount of 2,3,7,8-TCDD with an equivalent activity. This is known as a "2,3,7,8-TCDD equivalence factor" or TEF. The outcome of such procedures is to express the total cancer-enhancing potential of a mixture of PCDDs and PCDFs, such as occurs in incinerator emissions, as an amount of 2,3,7,8-TCDD with an equivalant effect on cancer incidence.

Risk Assessment Procedure

A proper assessment of the hazard due to exposure to PCDDs and PCDFs from incinerator emissions depends on a series of computations that are based on the following factors:

o The estimated concentration of PCDD/PCDF in the emissions from the incinerator stack. A single value representative of the total cancer-enhancing effect of all the PCDD/PCDF that occur in the emissions is then computed from the amounts of the different isomer groups (homologues) in the emission, and their respective TEFs. This value is expressed as an amount of 2,3,7,8-TCDD that has a cancer-enhancing effect equivalent to that of the mixture of PCDDs and PCDFs in the emissions.

o The degree to which the emissions are dispersed and diluted as they move downwind from the stack.

o The resultant maximum concentrations of PCDD/PCDF (expressed as 2,3,7,8-TCDD equivalents) in the air, at the point at which a person may be exposed to them.

o The 2,3,7,8-TCDD equivalents of PCDD/PCDF taken up by a person thus exposed, over a 70-year lifetime, computed as the amount taken up per kilogram of body weight per day.

o Comparison of this last figure (which, as noted above, is expressed as an equivalent amount of 2,3,7,8-TCDD) with a "dose-response" curve, which describes the increase in cancer incidence due to exposure to progressively larger doses of 2,3,7,8-TCDD, as determined from laboratory animal studies.

The final outcome of these computations is a determination of the number of additional cases of cancer (i.e., over and above the number of cases that would occur in the absence of the incinerator emissions) that is expected to occur in the exposed population under "worst case" conditions. Such a worst case risk estimate provides a safety margin by assuming that the entire population is exposed to the maximum concentrations of PCDDs and PCDFs in the air downwind from the incinerator. This risk estimate is expressed as some number of additional cases of cancer per million people constantly exposed to the maximum concentration of emissions over a 70-year lifetime.

Significance of the Risk

The significance of these risk assessments must now be considered -- that is, the operational meaning of a "worst case" cancer risk. In deciding whether or not to build an incinerator, it is necessary to consider whether its operation would release substances that create a risk of cancer which is considered unacceptable and hence subject to regulation. The Federal Clean Air Act requires the U.S. EPA to assess the cancer risk from exposure to airborne chemicals and, on that basis to decide whether (a) the substance should be listed as a "hazardous air pollutant" and steps taken to promulgate a regulatory standard, or (b) no action need be taken. EPA has considered a series of airborne substances in these terms, based on evaluations of their cancer risk.

The EPA Office of Air Quality, Planning and Standards has computed several types of risk assessments for airborne carcinogens, based chiefly on ambient air pollution data obtained from monitoring systems in a series of representative locations in the United States (Hunt *et al*., 1985; Hunt and Faoro, 1985). Table I lists the risk assessments for a series of airborne carcinogens along with the regulatory actions taken by EPA under Section 112 of the Clean Air Act. The data regarding the maximum lifetime risk may be compared with incinerator risk assessments, for in both cases the value is based on the effect of exposure to the maximum concentrations that people may encounter. It will be noted from Table I that a maximum lifetime risk as low as 0.83 per million (for methylene chloride) has triggered the EPA regulatory process.

In comparison, all of the risk assessments for existing and proposed incinerators are in excess of this value, some of them considerabley so. This comparison indicates that if the EPA is to be consistent in its actions PCDD/PCDF emissions from incinerators should be subject to EPA regulation.

The estimate of risk is proportional to the exposure level -- the higher the level of PCDD/PCDF in the stack emissions, the higher is the risk of developing cancer due to exposure to PCDD/PCDF. Thus, the first step in a risk assessment -- assuming what the emission rate from an incinerator will be prior to it being built and operated -- is a critical step in the risk assessment procedure. PCDD/PCDF emission rates expected from a proposed incinerator are based on published data regarding emission tests of other existing facilities. Table II is a compilation of these test results as of January, 1986. (For a more complete discussion of the standards for database inclusion see Commoner et al., 1986.)

Many risk assessments that have been carried out for a proposed incinerator have assumed that when the incinerator is built and operating, it will have PCDD/PCDF emission rates comparable to that of the Chicago, NW incinerator. Two reasons typically are given for this assumption: the proposed incinerator will operatate at high temperatures -- approximately 1800° F -- destroying any PCDD/PCDF present; the incinerator will have a high combustion efficiency, minimizing PCDD/PCDF emissions. These assumptions are factually incorrect. Analysis of the data available from incinerator tests show that PCDD/PCDF emissions are not in fact reduced by operating incinerators at elevated furnace temperature or high combustion efficiencies.

In tests conducted at the SWARU and Hampton incinerators, PCDD/PCDF emissions were determined under varying combustion conditions, and the number of observations are sufficient to warrant regression analyses of the relationship between furnace temperature or combustion efficency and emission rate. (Regression analysis is a mathematical procedure that determines whether variations in one factor -- in this case PCDD/PCDF emission rate -- are systematically related to variations in another factor, such as furnace temperature or combustion efficiency.) Regression analyses of both the SWARU and Hampton data reveal that there is no statistically significant relationship between furnace temperature or combustion efficiency and PCDD/PCDF emission rates. (Commoner et al., 1985)

Another proposed method for minimizing emissions of PCDD and PCDF is the use of control devices. The air pollution control device most often installed on incinerators is an electrostatic precipitator (ESP). Emission rates from incinerators equipped with an ESP vary over a 70-fold range (Commoner et al. 1985). Another device, a supplementary burner, in its only test thus far was also unable to reduce PCDD/PCDF emissions. The test results of an incinerator in Albany, New York that is equipped with such a device showed that about twice as much PCDD/PCDF was emitted with the burner on than with the burner off (570 vs. 310 ng/m^3) (NYSDEC 1985). Thus, both devices are not reliable for reducing emissions of PCDDs and PCDFs.

A newer proposed air pollution control device is the scrubber/fabric filter baghouse system. This device was first tested in a garbage-burning incinerator in Tsushima, Japan. In this test the device clearly failed to minimize PCDD/PCDF emissions -- the amount of PCDD exiting the scrubber/baghouse system was up to seven times higher than the amount entering the system (Cooper Engineers Inc., 1984). However, two recent tests of the scrubber/baghouse system show promise for this air pollution control device. Testing performed at an incinerator in Wurtzberg, Germany showed low PCDD/PCDF emissions (Hahn et al., 1986). The second test at an incinerator in Quebec is even more revealing (Hay et al., 1986). Unlike the Wurtzberg test, the test at Quebec measured PCDD/PCDF entering the pollution control device in addition to PCDD/PCDF exiting the device. In five out of six tests the removal efficiency for PCDD/PCDF exceded 99.9%. However, this test was performed only on a pilot scale.

The use of higher efficiency pollution devices to capture PCDDs and PCDFs poses another major problem -- how to dispose of PCDD/PCDF contaminated ash from the air pollution control device. Table III is a compilation of data as of January, 1986 on PCDD/PCDF levels in fly ash (Commoner et al., 1986). The average level is 9.69 or 74.9 ng 2,3,7,8-TCDD equivalents per gram, depending upon which method of calculating toxic equivalents is employed. There are no standards for PCDD/PCDFF in incinerator fly ash. As a basis for comparison, the U.S. Environmental Protection Agency has established 1 ng/g of 2,3,7,8-TCDD in soil as the level at which remedial action (clean-up) is required. Thus, in Times Beach, Missouri, and Newark, New Jersey soil contaminated with 2,3,7,8-TCDD in excess of 1 ppb was removed. Even if the fly ash is diluted with the grate ash, the mixture will exceed the 1 ng/g level. This disposal problem was realized in October 1984 in Philadelphia. New Jersey barred the disposal of fly ash from a Philadelphia trash-burning incinerator in its landfills after testing revealed 2-28 ppb of dioxin in the fly ash (Jaffe and O'Brien, 1984).

Thus, mass-burn incineration is not a viable alternative for the disposal of municipal solid waste. While landfills have created serious environmental problems, incinerators also pose serious environmental and health problems -- increased cancer due to exposure of stack emissions of PCDDs and PCDFs, and the disposal problem of the toxic ash residue. There are safer alternatives for the handling of trash, for example composting and recycling. These alternatives should be pursued instead.

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Table I

U.S. EPA CANCER RISK ASSESSMENTS AND REGULATORY ACTIONS TAKEN ON AIRBORNE ORGANIC CARCINOGENS

	Cancer Risk Per Million		
	Maximum Lifetime (70-year) Risk*	National Average Lifetime (70-year) Risk**	EPA Action
Benzene	154	71.4	Regulatory standard established (6/6/84)
Carbon Tetrachloride	154	13.3	Intend to List (US EPA, 8/13/85)
Chloroform	77	4.9	Intend to List (US EPA, 9/27/85)
Ethylene dichloride	18	12.6	Intend to List (US EPA, 10/16/85)
Formaldehyde	206	58.1	Under extended assessment
Methyl chloride	0.46	<0.7	No information
Methylene chloride	0.83	0.7	Listed**** (US EPA, 10/17/85)
Perchloro ethylene	18.8	7.0	Intend to List (US EPA, 12/28/85)
Trichloroethylene	25.9	5.6	Intend to List (Date NA)
Vinyledene chloride***	830	.02	No regulatory action (US EPA, 8/13/85)

*Data from Hunt et al. (1985). Table 9 (2 or more valid quarters) except for ethylene dichloride and formaldehyde, which, according to Hunt are erroneously reported there. For these compounds, values are the maxima reported in Tables 7a and 7b, which are accurate.

** Data from Hunt and Faoro (1985), Table 6

*** Data from EPA "Decision Not to Control Vinyledene Chloride and Solicitation of Information," Federal Register, Aug. 13, 1985, p. 32632. Decision based on inadequate evidence of carcinogenicity and small population exposure.

****Initiation of comprehensive regulatory investigation as required under section 4(f) of the Toxic Substances Control Act.

Table II

STACK CONCENTRATIONS OF PCDD+PCDF (TETRA-OCTA) EMISSIONS FROM MUNICIPAL SOLID WASTE INCINERATORS

Incinerator	Location	Stack Concentration PCDD+PCDF (ng/m^3)	2,3,7,8-TCDD Equivalents (ng/m^3)* EPA	 Swiss	Number of Samples
ANSWERS	Albany, NY	196(458)	2.37(4.8)	15.2(33.9)	2
Belgium-1	Belgium	2193	12.9	129	NA
Belgium-2	Belgium	1756	6.40	75.7	NA
Chicago NW	Chicago	192	1.03	17.3	3
Como	Italy	683(2382)	4.28(19.8)	39.2	14(16)
Eksjo	Sweden	541	2.42	45.3	2
Florence	Italy	1830	NA	NA	1
Hampton	Hampton, VA	10230	82.2	860	9
Italy-1	Italy	535	4.03	24.8	1
Italy-2	Italy	56460	490	3934	1
Italy-3	Italy	8952	83.7	704	1
Italy-4	Italy	7987	28.1	330	1
Italy-5	Italy	1503	8.74	93.9	1
Italy-6	Italy	639	7.21	52.9	1
Tsushima	Japan	4524	69	400	2
PEI	Canada	222	1.0	12.1	12
SWARU	Hamilton, Ont	12500	91.9	778	16
Toronto	Toronto, Ont	1900	NA	NA	3
Zaanstad	Netherlands	2455	16.1	150	9
Zurich	Switzerland	202	1.07	11.0	1
Average		5775	50.7	426	
Standard Deviation		12200	111	894	
Minimum		192	1	11	
Maximum		56460	490	3934	
Number of Samples		20	18	18	

*2,3,7,8-TCDD equivalents have been computed by two different methods. The values in the column headed "EPA" have been computed according to the method proposed by the U.S. EPA Chlorinated Dioxins Workgroup, "Interim Risk Assessment Procedures for Mixtures of Chlorinated Dibenzodioxins and -Dibenzofurans (CDDs and CDFs)" (U.S. EPA, April 1985). The values in the column headed "Swiss" have been computed according to the method proposed by the Swiss Federal Office for Environmental Protection, "Umweltbelastung durch Dioxine und Furane aus kommunalen Kehrichtverbrennungsanlagen" (Schriftenreihe Umweltschutz Nr. 5, Bern, Juni 1982).

Table III

CONCENTRATION OF PCDD+PCDF ON PRECIPITATED FLY ASH FROM INCINERATORS BURNING MUNICIPAL SOLID WASTE

Incinerator	Location	tetra-octa PCDD+PCDF (ng/g)	2,3,7,8-TCDD Equivalents (ng/g)		No. of Samples
			EPA 1985 Method	Swiss Method	
Alkmaar	Netherlands	2134	16.5	155	4
Amsterdam	Netherlands	915	3.62	40.2	5
Florence	Italy	4650	22.1	89.0	1
Hampton	Hampton,VA	3066	34.7	297	2
Italy-2	Italy	616	3.66	29.7	1
Italy-3	Italy	11.4	.04	.38	1
Italy-4	Italy	3854	34.5	266	1
Italy-5	Italy	2.06	.04	.16	1
Italy-6	Italy	7.8	$6x10^{-7}$	$1.2x10^{-5}$	1
Milan	Italy	313	.95	3.46	1
Netherlands	Netherlands	1985	13.9	128	4
Rome	Italy	968	7.35	7.43	1
SWARU	Hamilton,Ont.	69.4	.64	6.16	13
Tsushima	Japan	51.4	1.40	3.96	1
W. Germany	W. Germany	37.9	.07	1.66	3
Zaanstad	Netherlands	3665	24.5	236	9
Zurich	Switzerland	305	.77	8.41	1
Average		1332	9.69	74.9	
Standard Deviation		1533	12.0	100	
Minimum		2.06	$6x10^{-7}$	$1.2x10^{-5}$	
Maximum		4650	34.7	297	
No. Samples		17	17	17	

Notes:

Standards for inclusion in the database: i) Data include at least tetra through octa PCDD and preferably tetra through octa PCDF as well; ii) sources must be documented.

Italy-1 not included as fly ash data not available. Italy 2-6 measurements do not include P_5CDF, H_6DF, H_7CDF. Italy-6 test did not detect T_4DD, P_5DD, H_6CDD, T_4CDF, thus yielding low 2,3,7,8-TCDD equivalents values.

1 ng/g = 1 ppb.

ANALYSIS OF ALTERNATIVE DISPOSAL TECHNOLOGIES

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A. INTRODUCTION

Hazardous waste is the consequence of an industrialized society. The production of hazardous waste from industrial processes has occurred for decades. Throughout the United States, millions of tons of industrial waste materials are generated each year and much of it (an estimated 57 million metric tons in 1980) is considered hazardous. Waste management practices of generators has ranged from midnight dumping to incineration in permitted facilities.

The purpose of this presentation is to provide an overview of the alternative hazardous waste management technologies that are currently available or emerging. Overall effectiveness, applicable waste streams, operating costs, and associated risks are discussed for the various alternatives. The goal of the presentation is to provide information that will assist in making informed decisions concerning the proper management of hazardous waste.

Before selecting a management strategy for hazardous waste disposal, it is necessary to outline the basic characteristics of the wastes to be considered. The wastes that will not be examined here include radioactive wastes and energetic materials. Although many of the disposal options to be presented have been shown effective in the disposal of low level nuclear wastes, these materials are not the focus of this presentation.

The hazardous wastes that conform to the disposal options presented include toxic materials, carcinogens, reactive materials (excluding explosives), and corrosives. All physical forms will be included, i.e., gases, liquids, solids, slurries and sludges. The forms of disposal considered are thermal and chemical treatment.

1. Economic Comparison with Landfills

There are many techniques available for the disposal of hazardous wastes. The most common is land disposal in permitted hazardous waste landfills. Economics is the primary reason land disposal is most popular. Landfilling hazardous wastes is usually less expensive than alternative methods, especially in the short term.

Land disposal of hazardous wastes in drums can be as low as $10 per ton. In comparison, incineration of relatively clean liquid hazardous wastes costs about $50 per ton. For extremely hazardous wastes, land disposal ranges from $150 to $250 per ton; incineration of solid or drummed highly toxic wastes can cost from $400 to $800 per ton, while chemical treatment can cost as much as $790 per ton. Land disposal is simply more economical for hazardous waste management based on upfront expenditures. Certain techniques, such as solvent or metal recovery, or incineration of boilers, have positive economic factors that can make these management options more competitive with land disposal, but for disposal without resource recovery, land disposal is virtually always least costly.

Fundamentally, landfilling of hazardous wastes can be only considered as a long term storage management option. Most hazardous wastes are extremely stable (i.e., do not decompose easily), or contain elemental contaminants (e.g., metals) that are permanent. At best, landfilling only provides temporary containment of hazardous wastes; at worst, leaks develop in the landfill liner and contamination of the surrounding area will occur.

Over the last decade, landfill designs have become quite sophisticated. When properly sited, constructed and operated, newly designed landfills can store certain hazardous wastes for a very long time with a high degree of safety. However, perpetual maintenance and monitoring is required; eventually, however, the landfill will leak. The threat then posed to public health will depend on the nature of the waste escaping, the site hydrology, and proximity to ground water supplies. The disposal options discussed in the remainder of this presentation present options that avoid or minimize the need to use hazardous waste landfills.

2. Thermal Treatment Technologies

Thermal treatment processes destroy the molecular structure of a hazardous waste by using elevated temperatures usually in conjunction with oxidative environments. The performance of a thermal process is measured by its Destruction Removal Efficiency (DRE). Determination of DRE requires identification of Principal Organic Hazardous Consitutents (POHC) present in the waste. These compounds are stipulated by the U.S. Environmental Protection Agency. The amount of POHC in a hazardous waste can be a trace constituent in a waste stream (e.g., metals in a solvent used to strip the paint off aircraft), or the entire waste stream (e.g., a process that uses a toxic compound as the stripping agent). DRE is expressed as a percentage and is defined as follows:

$$\mathrm{DRE} = (1-w(out)/w(in)) \times 100$$

where, w(out) = mass-emissions rate of a given POHC in the exhaust as related to the atomosphere

w(in) = mass feed rate of the POHC in the waste stream going into the processing unit

The required DRE must be met for all identified POHCs in the waste stream. Since thermal processes only destroy the molecular structure and cannot change the elemental composition of the hazardous waste stream, toxic metals and halogens must be removed from the effluents, or be emitted at levels below maximum limits established for the process.

In the case of benzene, which only contains carbon and hydrogen in its molecule, thermal oxidation processes will produce at optimum operation virtually nothing but carbon dioxide and water. Thus, benzene would be completely removed from the environment and transformed into non-toxic materials (i.e., DRE = 100 percent). If the thermal process was poor, however, significant amounts of benzene, and carbon monoxide would be present in the emissions. The carbon monoxide would be classified as a product of incomplete combustion (PIC). In a more complex example, if PCBs were to be thermally destroyed, a potential PIC is dioxin, and hydrogen chloride is a known effluent. Under current standards, if the process is incineration, and the emissions rate of hydrogen chloride is greater than 4 lb/hr, a scrubber with an efficiency of at least 99 percent would be required above and beyond demonstrating a 99.99 percent DRE of the POHC.

The concept of thermal treatment is to destroy the molecular structure of a hazardous material and rearrange the atoms into compounds that are non-hazardous. If it is not possible to form non-hazardous compounds, the process is then designed to emit hazardous materials in concentrations that are environmentally acceptable, or remove hazardous effluents from the exhaust stream. In the latter case, the thermal process is itself a hazardous waste generating process. The value of the process is to reduce the volume of hazardous waste. The concentrated hazardous waste materials are removed for further treatment (as described later), used for resource recovery, or landfilled.

Thermal treatment processes attempt to utilize the chemical energy available in the hazardous waste for stable operation. Often, the incinerability of a material is judged on the heating value of the waste. The criteria needed to evaluate a waste for thermal treatment, however, goes beyond evaluating its chemical energy content. Often, even if the heating value of a given waste is low, it is usually possible to mix or co-burn the low energy waste with a high energy waste, or if necessary, mix it with a supplemental fuel (e.g., fuel oils).

Thermal processes offer the potential for heat recovery with the use of auxiliary equipment. Thermal treatment in boilers will be discussed in detail later.

Thermal treatment technologies are broken down into incineration and emerging thermal treatment technologies. The emerging thermal treatment technologies discussed in this presentation are molten salt, plasma arc, wet oxidiation and super critical water.

B. INCINERATION

The U.S. EPA uses performance standards to regulate incinerators. The current standards (40 CFR, Sec. 264.343) are:

- The destruction and removal efficiency (DRE) must meet or exceed 99.99 percent for each principal organic hazardous constituent (POHC).
- Incinerators that emit more than 4 lbs of hydrogen chloride per hour must be fitted with exhaust gas cleaning equipment capable of at least a 99 percent hydrogen chloride removal efficiency.
- Particulate emissions cannot exceed 180 milligrams (mg) of particulate matter per dry standard cubic meter of stack gas.

Incineration is basically limited to the system's ability to transform the POHC into the gas phase, decompose it, oxidize its carbon and hydrogen atoms, and remove or significantly dilute its non-hydrocarbon atoms. This is accomplished in the incinerator by combustion (i.e., heat addition and oxidation), and in the effluent stream by air pollution control devices. The important factors in incineration are the ease of transforming the POHC into the gas phase, the ease of delivering oxygen to the gaseous POHC, the length of time the POHC is resident in a high temperature oxidizing environment, and the effectiveness of the scavenging process for collecting undesirable species before exhausting the effluent to the atmosphere.

Depending on the form of the hazardous waste (i.e., gaseous liquid, solid, slurry or sludge), and the volatility of the POHC, the time required to vaporize the POHC can vary considerably (from 0 sec in the gas phase to milliseconds in the liquid phase, to hours in the solid phase) and as a result, different incineration techniques are necessary.

The following types of incineration are considered:

Liquid Injection Incineration

Boilers

Rotary Kilns

Cement Kilns

Multiple Hearth

Fluidized Bed Incinerators

Pyrolysis

1. Liquid Injection Incineration

Liquid injection incineration is currently the most widely used incinerator design. This is due largely to the fact that many industrial plants use this technology for on-site disposal of hazardous wastes. Liquid injection incinerators have low maintenance costs and are relatively easy to operate since they have virtually no moving parts and they respond quickly to changes in operating conditions. As the name implies, liquid injection incineration requires the hazardous waste to be liquid. Liquid injection incineration, however can be applied to gaseous wastes and in some cases, slurries. A schematic of a liquid injection incinertor is shown in Figure 1.

The success of liquid injection incineration is dependent upon good atomization of the hazardous waste. Good atomization will produce small droplets resulting in very short evaporation times. This is essential in this type of unit because total residence times for all materials in the host section of the incinerator are relatively short (i.e., fractions of a second). During the time the POHC is in the hot section, it must vaporize, decompose, and its hydrogen and carbon atoms must oxidize. Much has been done in the way of evaluating the kinetics of decomposition and oxidization of POHCs, but the true limiting factor in all incinerators is the time required to vaporize the POHC and mix it with oxygen. Thus, the important factors in good incineration are heating value of the injected waste, volatility of the waste and the POHCs, the surface tension of the hazardous waste, and the atomization technique used for droplet generation.

The energy necessary to maintain the steady state operation of an incinerator is usually supplied by the hazardous waste as it burns. If, however, wastes of lower energy than that necessary for stable combustion need to be used, the lower energy waste can be co-burned with a higher energy waste or fuel in order to maintain a steady state operation.

Once the hazardous waste has been incinerated, the combustion gases must be cleaned to meet EPA regulations. If hydrogen chloride (HCL) emissions exceed the minimum amount, the exhaust gases must be passed through a scrubber to remove at least 99 percent of the HCL. The incinerator must also meet EPA's particulate emissions standards.

Currently, all ocean incineration vessels use liquid injection incineration. The advantage of ocean incineration is the absence of HCL and particulate emissions standards. This makes the incinerator much less complex (except that is is aboard ship). Storing hazardous wastes at ports while awaiting transfer to ships, and the threat of spills during transfer appear to be the major obstacles of ocean incineration (one must realize, however, that chemicals just as toxic or as dangerous as hazardous wastes are

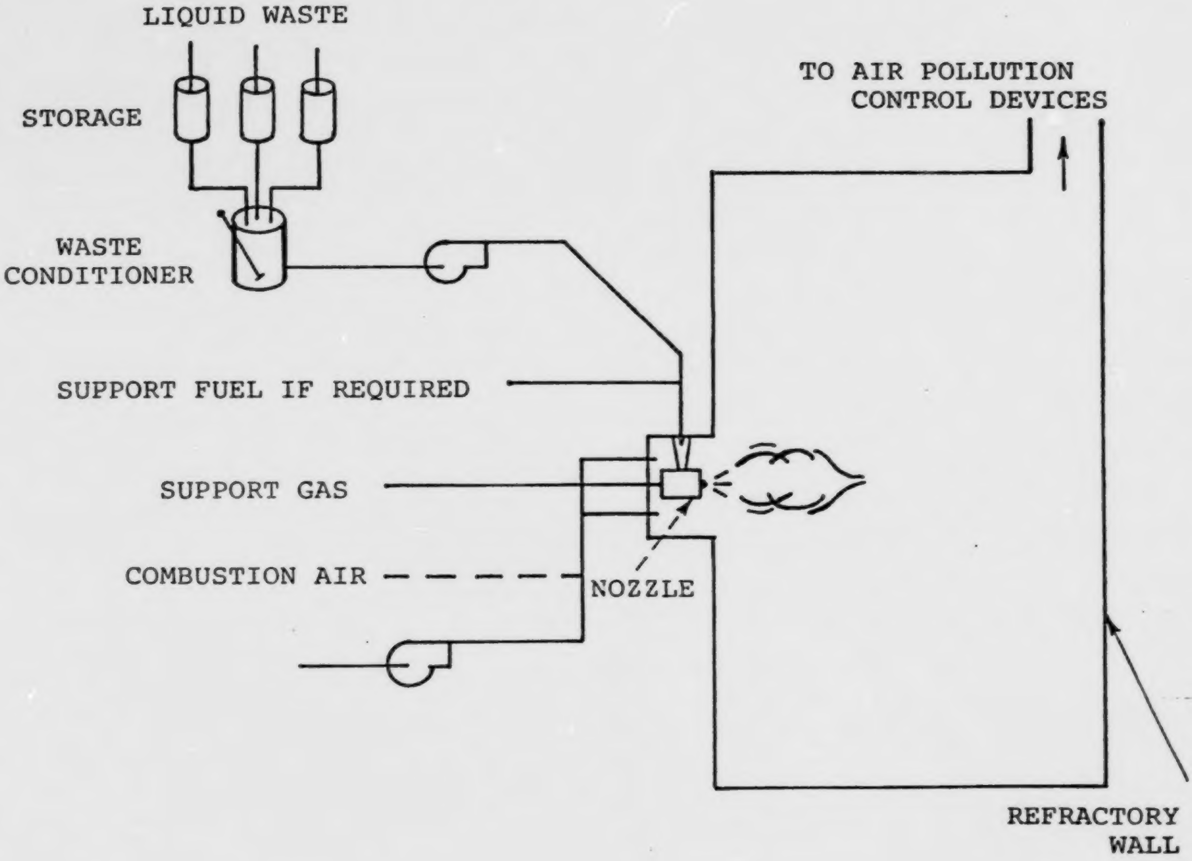
LIQUID WASTE
STORAGE
WASTE CONDITIONER
TO AIR POLLUTION CONTROL DEVICES
SUPPORT FUEL IF REQUIRED
SUPPORT GAS
COMBUSTION AIR
NOZZLE
REFRACTORY WALL

Figure 1. Liquid Injection Incinerator.

passed through ports everyday; they simply are not waste materials, but are solvents, oils and so on, destined to become hazardous wastes after use).

Incinerators, and liquid injection incinerators in particular, often burn materials that create very corrosive combustion products. Consequently, refractory wall and exhaust stack maintenance is of great concern. When a well defined waste stream is used, maintenance is standardized; however, when a variety of waste streams are burned, maintenance is more difficult.

2. Boilers

Boilers are designed primarily as stream generation units with hazardous waste treatment being a secondary function. By design, boilers are excellent heat recovery units; it so happens that they can use some hazardous wastes as fuels. Incinerators are specifically designed to achieve high destruction removal efficiencies of hazardous wastes. While incinerators have refractory walls which are quite hot during operation boilers usually have metallic tubular walls which are cooled by water passing through them. Despite the differences between boilers and incinerators, a boiler when operated correctly can serve as an excellent hazardous waste treatment unit.

Liquid hazardous wastes are the predominant waste type disposed of in boilers. In liquid injection boilers, wastes are co-incinerated with the primary fuel. The results are significant reduction in fuel costs, and a significant reduction in liquid waste disposal costs. Care must be exercised in the operation of the boiler to avoid severe corrosion of boiler components. This factor is more important for a boiler than for the previously mentioned liquid injection incinerator because in the boiler, many components operate at significantly reduced temperatures than in the incinerator, and it is in cooler regions that corrosion problems usually occur.

Care must be exercised so as not to allow too many corrosive products of combustion to be formed. This is done by limiting the input rate of the hazardous waste. Also, boilers with moving grates or stokers can also accept some of the wastes that are candidates for rotary kiln incineration. Restrictions on waste material size (e.g. 55 gallon drums) introduced into the boiler may need to be considered, but shredders can be used to overcome this problem.

The use of boilers in hazardous waste management is very attractive because of the large number of boilers in operation. Recognizing this fact, the U.S. EPA has outlined the use of industrial boilers for the disposal of PCBs in 40 CFR, Part 761. If public concerns about the incineration of hazardous wastes can be dealt with more effectively, industrial boilers may become a more widely used option for hazardous waste management.

3. Rotary Kilns

Rotary kilns are the most versatile thermal technology currently available, and conventionally, the most expensive to build and operate. They can accomodate virtually all forms of hazardous wastes (i.e., gases, liquids, solids, slurries and sludges), and they realize tremendous economies of scale.

Rotary kilns are used by industrial plants for on-site hazardous waste treatment, but to a much more limited extent than liquid injection incinerators. The rotary kiln is often the focal point of a large, multi-purpose hazardous waste management facility.

Figure 2 is a schematic of a rotary kiln. Gravity and the rotating cylinder of the kiln provide the necessary motion to advance solids through the furnace and cause the solids to tumble. This action strips off burnt layers and uncovers fresh fuel and hazardous materials, and enhances uniform heat transfer. Slurries and sludges are fed into the kiln and behave much like the solids. Liquids can either be fed into the kiln or injected through a burner gun. The latter is preferred since it would significantly enhance heat addition near the head of the kiln.

Cylinders used in rotary kilns range in size from 3 feet in diameter and 8 to 10 feet long, up to 15 to 20 feet in diameter and about 30 feet long. They operate at temperatures ranging from 1500 to 3000°F depending on location, and typical capacities are from 1 to 8 tons per hour. Large, fixed capacity may be a disadvantage if insufficient or irregular waste quantities are available for management on a continuous basis.

The rotary kiln can incinerate a wide variety of liquid, solid, slurry, and sludge wastes. It can also incinerate materials passing through the melting phase (e.g., PCB wastes in capacitors). Its adaptability to different feed mechanisms allows it to accept hazardous waste feeds in the form of drums and bulk containers. By varying the rotational speed of the kiln, retention times for solids can be hours. However, spherical or cylindrical wastes may roll through the kiln before complete combustion is achieved.

4. Cement Kilns

A cement kiln is a special type of rotary kiln. Usually, liquid organic wastes are co-fired with base fuels in the kiln. Good mixing and long residence times are characteristic of these facilities. The temperture range in the cement kiln lies between 2600 and 3000°F. These long residence times and high temperatures permit incineration of even the most stable compounds.

The alkaline environment in the kiln acts to neutralize hydrochloric acids produced from the incineration of chlorinated wastes. Ash and nonvolatile heavy metals are incorporated into the

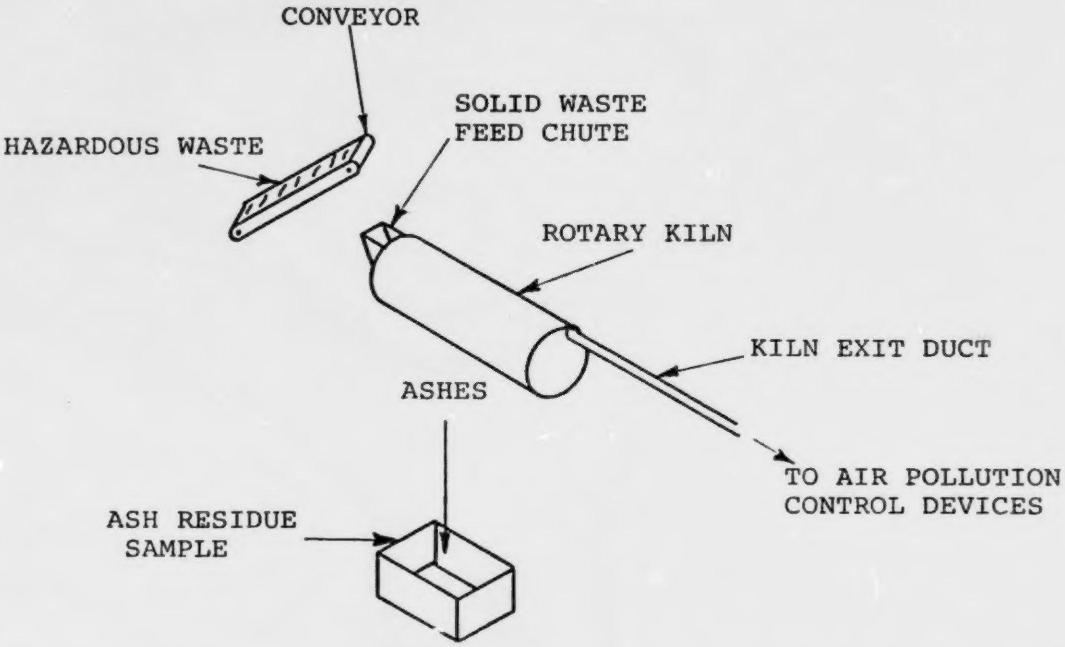
CONVEYOR
SOLID WASTE FEED CHUTE
HAZARDOUS WASTE
ROTARY KILN
KILN EXIT DUCT
ASHES
TO AIR POLLUTION CONTROL DEVICES
ASH RESIDUE SAMPLE

Figure 2. Rotary Kiln.

clinker (the kiln product), and eventually into cement. Ash and heavy metals that are carried over into the kiln dust are collected in the air pollution system of the kiln, and either recycled into the kiln or landfilled.

Cement kilns have no theoretical limit on the fuel-to-waste feed ratio; the only requirement is that the feed have sufficient heating value to fire the kiln. Cement kilns which are not currently in use represent additional capacity for alternative hazardous waste management.

5. Multiple Hearth Incinerator

Multiple hearth incinerators consist of a vertical incinerator cylinder with multiple horizontal, cross-sectional floors or levels (Figure 3). Wastes cascade from the top level to each subsequent level. The primary application of this type of unit is for the incineration of sludges. Some multiple hearth incinerators are currently used for hazardous wastes, but due to two inherent design characteristics, they are poorly suited for the incineration of most hazardous wastes.

Multiple hearth incinerators exhibit what are known as cold spots in various locations throughout the unit. Consequently, uniform degradation of hazardous waste in the unit is difficult to promote. The classical design of multiple hearth incinerators allows hot gases to exit from the top of the unit; since the wastes are fed into the top of the incinerator, volatile gases can escape from the top of the incinerator and into the environment before experiencing adequate incineration time in the hot regions of the incinerator.

6. Fluidized Bed Combustors

The use of fluidized beds in combustion systems is relatively new. The fluidized bed combustor (Figure 4) consists of a central volume or bed of granules which fluidize when air is forced up through a perforated plate at the bottom of the combustor. Fuel and waste are injected onto the bed where rapid heat transfer occurs. Because of the compact design of fluidized bed combustors, relatively low capital costs are involved in their construction.

Fluidized bed combustors were originally developed to provide a combustion system that would have low nitric oxide emissions. Such emissions are caused by the thermal fixation of atmospheric nitrogen at the high combustion temperatures typically found in conventional boilers. The fluidized bed combustor, by design, operates at temperatures lower than those found in incinerators and boilers. Fundamentally, this works against fluidized bed combustion as a hazardous waste incinerator because high tempertures are important in destroying the molecular

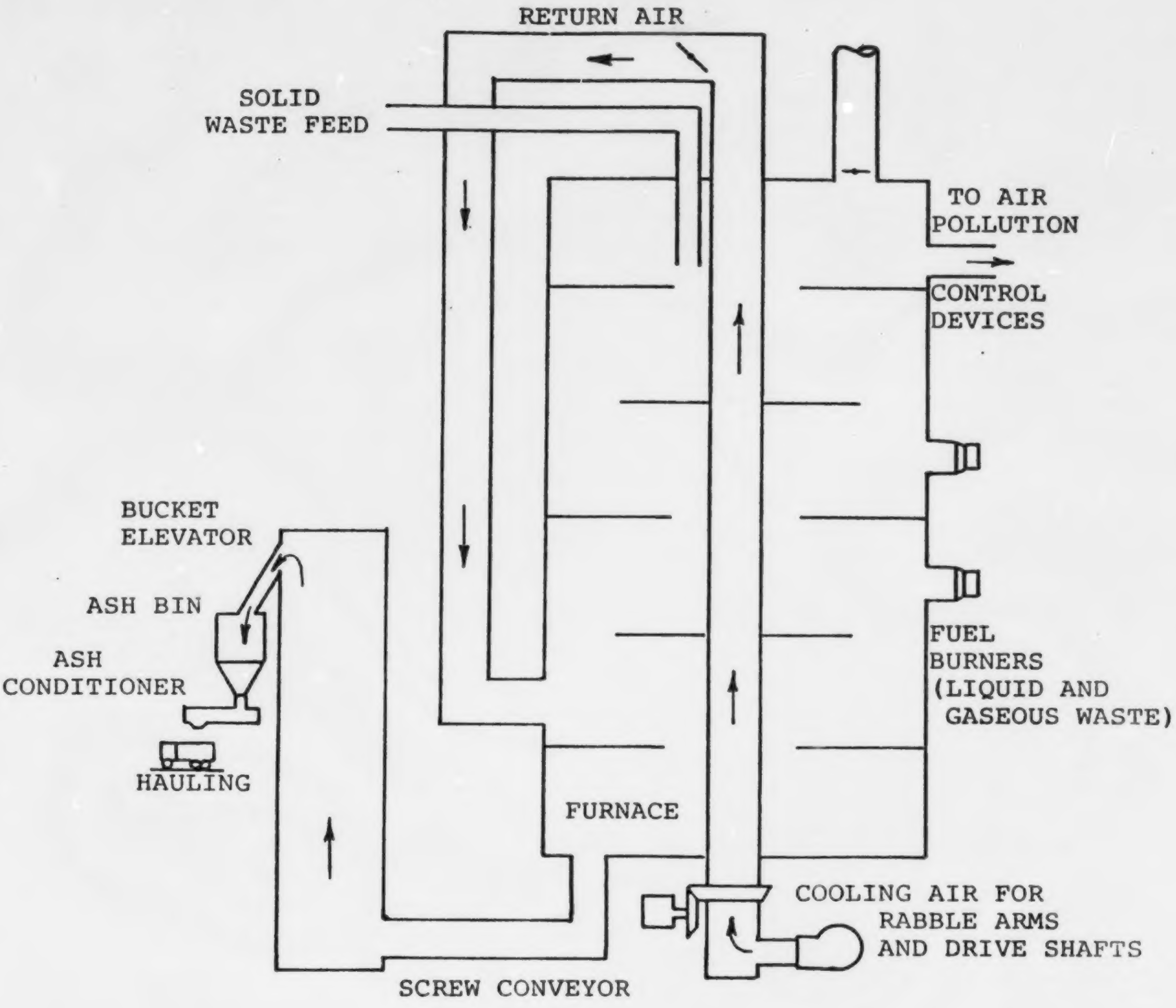
RETURN AIR
SOLID WASTE FEED
TO AIR POLLUTION CONTROL DEVICES
BUCKET ELEVATOR
ASH BIN
ASH CONDITIONER
HAULING
FUEL BURNERS (LIQUID AND GASEOUS WASTE)
FURNACE
COOLING AIR FOR RABBLE ARMS AND DRIVE SHAFTS
SCREW CONVEYOR

Figure 3. Multiple Hearth Incinerator.

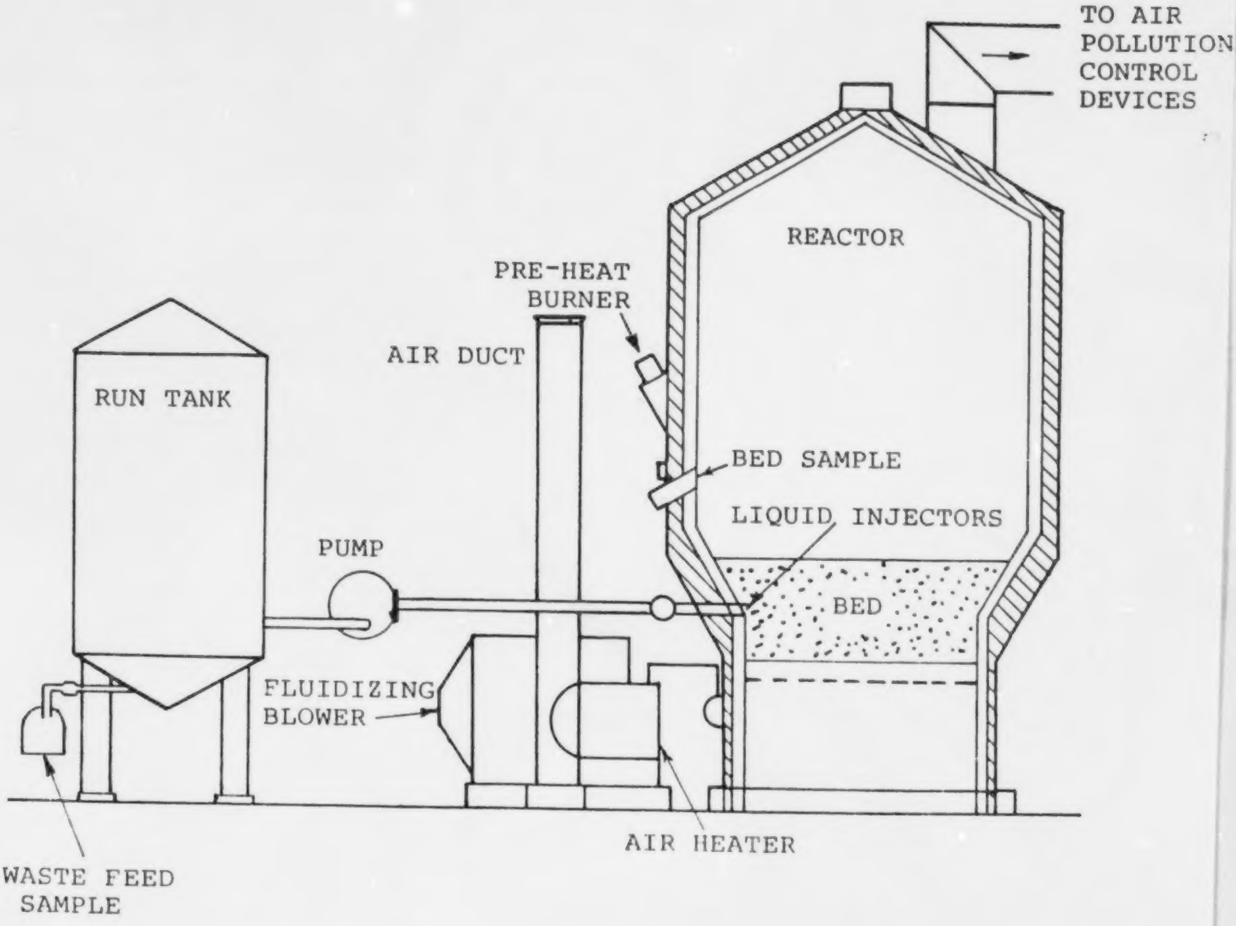
TO AIR POLLUTION CONTROL DEVICES
REACTOR
PRE-HEAT BURNER
AIR DUCT
RUN TANK
BED SAMPLE
LIQUID INJECTORS
PUMP
BED
FLUIDIZING BLOWER
AIR HEATER
WASTE FEED SAMPLE

Figure 4. Fluidized Bed Combustor.

structure of hazardous wastes. Fluidized bed combustors have two very important positive features that compensate for their lower operating temperatures; due to the thermal inertia of the fluidized bed, longer residence times in the hot region can be achieved, and depending on the selection of the fluidized bed material, the bed can act as a scrubber for certain gases (e.g., hydrogen chloride emissions) and particulates. Fluidized bed combustors are poorly suited for irregular or bulky wastes, or wastes that are tarry or have a high fusible ash content. Possible operating difficulties also exist for wastes with high moisture content.

Fluidized bed combustors have relatively long design lifetimes and have low maintenance costs, however, their operating costs, particularly power costs, are relatively high. The major disadvantage of fluidized bed combustion in a large general purpose facility is its limited throughput. However, when limited to smaller runs or, specialized cases it can be quite effective. Rollins Environmental Services, Inc., has developed a small rotary kiln sand-fluidized bed reactor for hazardous waste disposal applications.

One aspect of fluidized bed combustor technology that is just not being investigated, and has potential in hazardous waste management, is the development of catalytic fluidized beds. However, an obstacle in utilizing this technology is the matching of specific catalysts to various hazardous waste streams.

7. Pyrolysis

Unlike the techniques discussed previously, pyrolysis involves the thermal destruction of hazardous wastes in an oxygen starved environment. The advantage of this technique is that it avoids the volatilization of inorganic compounds. These inorganic materials (e.g., heavy metals) are reduced to an insoluble, easy to handle residue. Organic materials are volatilized and burned in a fume incinerator which operates downstream of the pyrolysis chamber. Since the organic compounds react to form carbon dioxide and water in the fume incinerator, and the inorganics are collected in the residue, minimal air pollution control devices are needed.

Pyrolysis has been used succfessfully by the federal government to destroy chemical warfare agents. The elevated temperatures (1000 to 1700°F) and long residence times achieve adequate destruction of hazardous materials; the oxygen starved environment provides for excellent material handling (i.e., all the material being processed can be retained in the pyrolysis chamber - air need not flow through the system as with other techniques).

As a general purpose facility, pyrolytic units have several disadvantages. Since little or no air is used for the pyrolysis process there is a greater potential for the formation of products of incomplete combustion (PICs). If an aqueous tar is produced, it may be difficult to dispose of, either in a landfill or an incinerator. Supplemental fuel costs are significant in producing the pyrolytic temperatures necessary to properly operate this equipment.

Midland-Ross Corp., Energy Technology Division has been working with pyrolytic units for several years. As prime contractors for two projects for the Chemical Systems Laboratory, U.S. Army, they developed units for the demilitarization and deactivation of undrained munitions, chemical agents, and contaminated explosives and rockets. They have also developed units for the pharmaceutical industry and electronic component manufacturing industry.

C. EMERGING THERMAL TREATMENT TECHNOLOGIES

1. Molten Salt

Molten salt reactors (Figure 5) are capable of achieving very high destruction due to several key factors. The molten salt beds in these reactors permit rapid heating of the waste feed, and the bed often acts as a scrubber for the product gases. Through proper selection of the salt, it is possible to neutralize some acidic materials, such as hydrogen chloride, that result from the degradation of some hazardous wastes (e.g., PCBs).

Molten salt reactors can accept gases, liquids, solids (sized to 1/4 to 1/8 inch diameters), slurries and sludges. Molten salt reactors operate between 1500 and 1800°F. If the waste stream fed into the reactor has a heating value in excess of 4000 Btu/lb, the energy generated from the combustion process will maintain the reactor temperature for steady state operation. This required heating value is about one-half that required by other incineration techniques to maintain a stable process. This is because near-complete combustion reactions occur in the bed instead of downstream, as is the case in incinerators (excluding fluidized bed reactors).

Although the products emitted from the molten salt reactor are often cleaner then those emitted by other techniques, inorganic materials that were in the original hazardous waste are still present in the system and must be managed. A common salt used in reactors is sodium carbonate. Halogenated organic wastes or wastes containing materials such as phosphorus or arsenic react with this salt to produce new inorganic products. These new inorganic materials reduce the acid pollutant removal capability of the bed and therefore must be removed. The result is a hazardous waste produced as a result of the treatment process. Ash present in the input hazardous waste stream is collected in the molten salt bed and must be removed to preserve the fluidity of the melt.

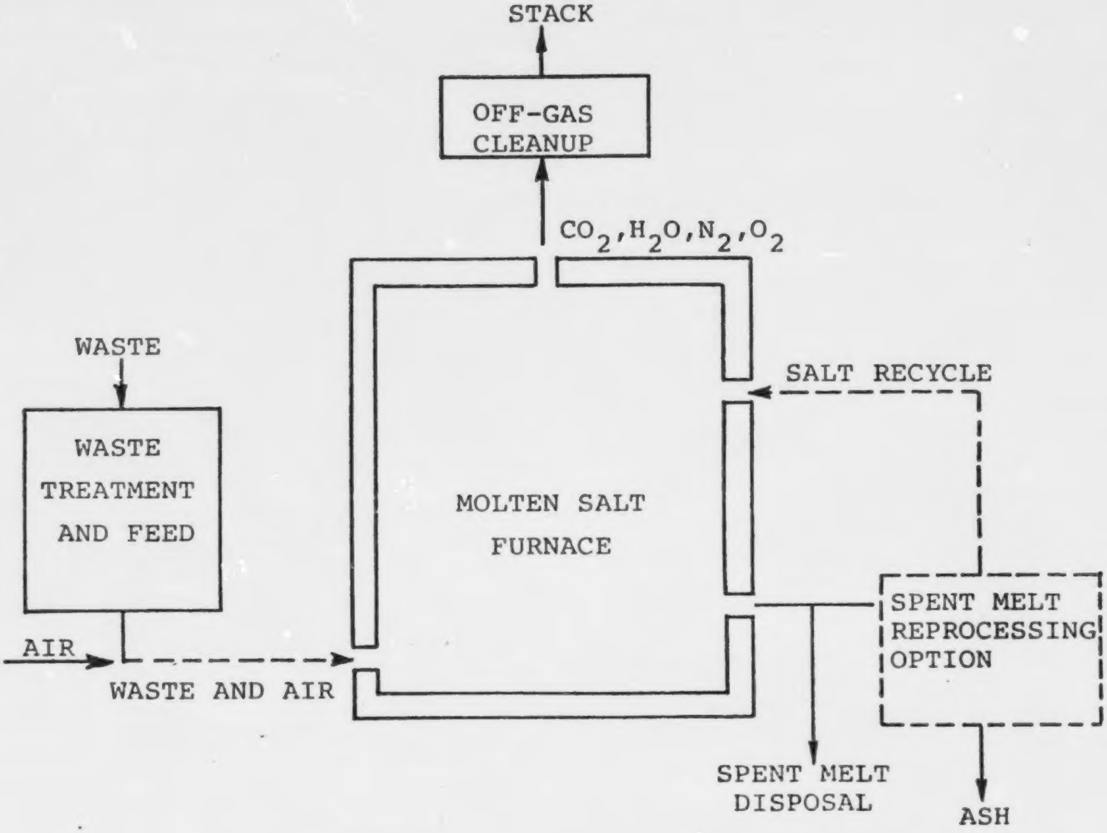
STACK
OFF-GAS CLEANUP
CO2,H2O,N2,O2
WASTE
WASTE TREATMENT AND FEED
AIR
WASTE AND AIR
MOLTEN SALT FURNACE
SALT RECYCLE
SPENT MELT REPROCESSING OPTION
SPENT MELT DISPOSAL
ASH

Figure 5. Molten Salt Furnace.

Molten salt reactors have been used to dispose of many of the most stable hazardous wastes and some of the most toxic. Tests at Edgewood Arsenal were preformed on three chemical warfare agents: VS, GB, and mustard. The results were excellent; all destruction removal efficiencies were better than 99.99998 percent. Tests conducted elsewhere on pesticides and other chemical wastes were not as remarkable, but DREs were still better than 99.99 percent. A summary of materials managed by molten salt combustion is given in Table 1.

From an economic viewpoint, some wastes are not well suited for molten salt combustion. These are wastes that have high ash content and would require frequent salt replacement or salt reprocessing, or wastes that are less than moderately hazardous (e.g., municipal wastes and sludges) and can be managed by less expensive processes.

The greatest impediment in the development of molten salt technology has been corrosion of the molten salt reactor vessel. The naturally corrosive environment produced by the elevated temperatures and salt melt in the reactor present severe operational and maintenance problems for traditional refractory-lined molten salt units. Recently, however, Rockwell International developed a steel alloy reactor vessel warranted for 1 year. Although very specific operating constraints must be met, this development represents a significant advancement in molten salt technology.

If the reliability of molten salt reactors can be improved, it may well be the best alternative for hazardous waste management, especially when a very high degree of destruction is vital (e.g., disposal of chemical warfare agents). Molten salt combustion has been demonstrated as a management option for many hazardous industrial wastes, pesticides, chemical warfare agents, and carcinogenic materials. This process has a distinct advantage over conventional incinerators by virtue of its internal scrubbing characteristics. Since virtually no acidic gaseous pollutants, sulfur dioxide, or nitric oxides are emitted, most pollution control devices are unnecessary. The advantage of molten salt technology over a fluidized bed containing granules capable of reacting with acidic gases is the result of the difference between a real fluid and fluidized bed. The melt provides a greater amount of contact between the gases passing through the reaction region and the scrubbing medium than a fluidized bed of solid particles; furthermore, coating of the solid particles in the fluidized bed by neutralization products can significantly reduce the acid gas scavenging characteristics of the fluidized bed. Another feature of the molten salt combustor is that the main constitutent of the melt is usually sodium carbonate; a stable, nonvolatile, inexpensive, and nontoxic material. Molten salt reactors show great promise in hazardous waste management; however, their economic viability has yet to be proven.

TABLE 1. Hazardous Wastes Managed by Molten Salt Technology

Chemical Warfare Agents

- GB
- VX
- Mustard

Chemical Wastes

- PCB
- Perchloroethylene Bottoms
- Trichloroethane
- Chloroform
- Diphenylamine-HCI
- Nitroethane
- Paraarsanilic Acid

Pesticides

- DDT
- Malathion
- 2,4D

Combustible Waste from Nuclear Plant

- Tributyl Phosphate
- Ion Exchange Resins
- Silicon Carbide
- Leaded Gloves
- Aqueous Solutions

2. Plasma-arc Reactors

A plasma is created by passing an electric current through a gas (e.g., neon lights). The plasma is a material containing high energy electrons. When a hazardous waste is exposed to the plasma, energy is transferred directly from the plasma to the waste. Violent processes ensue, causing the atomization, ionization, and ultimate destruction of the waste. Since destruction of the hazardous waste results from direct energy transfer to chemical bonds within the waste, the process is not restricted by conventional oxidation or combustion chemical kinetics and processes. Consequently, the formation of toxic products of incomplete combustion is less likely than that for conventional techniques.

Recent tests have demonstrated excellent destruction results (99.9999999%) from this technique for PCB dielectric fluids, but extensive data on other materials is lacking. The major market for this technique appears to be halogenated wastes, and commercial units will probably be small self-contained, and mobile. Although the costs for this technique maybe competitive with incineration, its application appears somewhat limited. Depending on the input waste material, a positive result of using this technique might be the production of gaseous fuels.

3. Wet Oxidation

Wet oxidation is a proven technology in the disposal of nonhalogenated organic wastes. It is through development of catalytic wet oxidation processes that this technology can play an important role in hazardous waste management. Wet oxidation reactions occur in the liquid state. Process temperatures are on the order of 430 and 660°F, and process pressures as great as 1,000 to 2,000 psi are used. For most applicable waste streams, the oxidation reactions produce enough energy to produce low pressure steams. Typically, 80 percent of complete reaction to carbon dioxide and water is achieved in the reactor, and the balance of the waste feed is degraded to low molecular weight organic acids. Current commercial application of wet oxidation is for aqueous organic waste streams which are too toxic for biological treatment and too dilute for incineration.

The most recent advancement in wet oxidation technology has been in the development of a patented catalyzed wet oxidation process by IT Corporation. IT's bench scale research has demonstrated that the use of a proper catalyst can promote oxidation of highly chlorinated organics in wet oxidation processes.

If acceptable destruction efficiencies can be achieved, wet oxidation could compete with incineration as a management option for liquid hazardous wastes. Wet oxidiation has the advantage of no air emissions, and a well established monitoring technology.

4. Super Critical Water

The critical state of water is 374°C and 220.9 bars (218 atmospheres). At temperatures and pressures greater than the critical state, water exhibits some unique characteristics. It becomes an excellent solvent for organic compounds and it fragments large organic molecules into lower weight molecular species. The injection of oxygen into super critical water containing organic hazardous wastes results in the oxidation of carbon and hydrogen fragments to carbon dioxide and water.

Bench scale tests indicate DREs in excess of 99.99 percent for DDT and PCBs; however, scale up factors still need to be assessed. As with wet oxidation, super critical water reactors could produce process steam given appropriate input waste streams, but safety factors in the operation of a full scale system require investigation. The energy requirements to produce the super critical water and the cost of compressed oxygen may be significant.

D. CHEMICAL TREATMENT TECHNOLOGIES

Chemical treatment technologies can be divided into three general types: neutralization, detoxification, and stabilization (or fixation).

1. Neutralization

Neutralization is simply the mixing of an acid with an alkaline for the purpose of pH adjustment. This is a common practice used in the treatment of acidic or basic waste streams. Neutralization is often a required pretreatment at land disposal sites. For some waste streams, neutralization can affect the precipitation of metallic components, thus providing for recovery of the waste through filtration. Although widely used for the on-site treatment of industrial waste, neutralization has a limited role in the overall management of hazardous waste.

2. Detoxification

Detoxification is usually waste specific. Reagents are developed to selectively attack chemical bonds and render the waste nontoxic. Most of the work in this area has focused on the development of reagents capable of chemically stripping chlorine from PCB-type chemicals thus producing a salt and an inert sludge, and in the case of dielectric fluids containing PCBs, to also produce non-PCB-contaminated oil.

Systems to dechlorinate PCB-laden oils are commercially available from two companies: Sunohio and Acurex. Both processes reduce PCB concentrations in transformer oil from as much as 5000 PPM to less than 2 PPM. Sunohio's PCBX process permits direct recycling of transformer oil back into transformers. Oil from the Acurex process is often used as fuel in boilers (dechlorination prior to combustion in boilers may be desired by boiler operators concerned with corrosion problems associated with burning PCB materials: however, for most PCB materials, direct incineration under EPA regulations for PCB dielectric fluid in boilers is adequate).

These systems hold the potential to process materials similar to PCBs (e.g., materials having carbon-halogen bonds). The reagents may detoxify some pesticides and other halogenated organic wastes. Some investigation into these alternative applications has been conducted, but no conclusive findings have resulted.

3. Stabilization/Fixation

Stablilization/fixation is the process of immobilizing hazardous wastes in a matrix (solid form). When successfully accomplished, the treated hazardous waste can be contained within the stable matrix. The matrix material is usually placed in a land encasement for permanent storage. Stablex Corporation has been successful in developing a method for immobilizing hazardous wastes in well developed matrices, and currently operates in Canada and the U.S.

E. CONCLUSIONS AND RECOMMENDATIONS

Several technologies can be applied to hazardous wastes. These are liquid injection incineration, utilization of boilers, fluidized bed combustion, molten salt and plasma arc. Of these, only liquid incineration and boilers have a proven track record for broad application and reliability. The most promising emerging technology is molten salt, followed by plasma arc; however, engineering complications must be overcome before these technologies will see broad application.

The use of boilers is the most viable option. Most installations have boilers that are capable of destroying typical hazardous wastes. Using this scenario, no installation costs are incurred, and little upgrading would be necessary. The primary cost in establishing a disposal capability is in the testing of the facility to verify that it meets EPA requirements.

PERMITTING AND ENFORCEMENT OF HAZARDOUS WASTE FACILITIES

Charles Biedermann
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Tallahassee, Florida

The Resource Conservation and Recovery Act (RCRA) which was enacted in 1976 and amended in 1984, established the framework for the hazardous waste regulations. It set up three general groups of hazardous waste management activities. The generators, where the waste originates; the transporters, which are involved in the movement of the waste from the generator to its ultimate disposal site; and the treatment storage and disposal facilities.

In 1980, the Environmental Protection Agency (EPA) promulgated rules to address hazardous waste management in the 40 Code of the Federal Regulations (CFR), Parts 260-266. Part 260 includes definitions and variance procedures; Part 261 defines solid wastes, hazardous wastes being a subset of solid wastes; Part 262 includes regulations for generators of hazardous waste; Part 263 covers transporter regulations; and Parts 264 and 265 are the regulations covering treatment, storage, and disposal at hazardous waste facilities. (Part 265 is the interim status regulations and Part 264 are the final or permitable standards.) Part 266 includes special standards for special wastes or special waste management activities.

The Florida Department of Environmental Regulation (FDER) adopted the federal rules in Chapter 17-30, Florida Administrative Code. As a result, the EPA has authorized the state to administer the hazardous waste regulations for them. Consequently, Florida is the primary permitting authority for hazardous waste facilities. Permitting efforts started in 1983.

Only treatment, storage and disposal facilities are currently permitted. A storage facility accumulates hazardous wastes over an extended period of time. Treatment is a chemical or physical method used to render a waste less hazardous or to reduce its volume. Disposal operations are limited to landfilling of wastes and have been banned in Florida since 1983, by the Water Quality Assurance Act.

I should mention that there are certain treatment, storage and disposal activities which are collectively called land disposal facilities. This is defined as any operation where the hazardous waste is placed on the land or on the water. Obviously, it affords the greatest potential for contamination. Processes that are defined as land disposal operations are surface impoundments, waste piles, land treatment units, and landfills. EPA has instructed the states to expedite the permitting efforts on these facilities.

Hazardous waste permitting requirements on the federal level are specified in 40 CFR, Part 270. Equivalent state requirements are found in Chapter 17-30, F.A.C., Part IV, Permitting Requirements; and Chapter 17-1, F.A.C., Permit Application Form. When a facility applies for a hazardous waste permit, the FDER performs a very detailed review of every aspect of the facilities waste management operations.

Some of the things we look for in a permit application include location standards, security procedures, operating procedures and the record keeping and recording procedures of the facility, a very detailed chemical analysis of all the hazardous wastes that the facility will manage, preparedness and prevention procedures and the contingency plan, and training plans. For land disposal facilities we also have extensive groundwater monitoring requirements. This includes corrective action provisions if any contamination of the groundwater is detected. We also review process specific considerations and standards, such as the engineering design of the facility, its structural capabilities, the containment systems, the liner systems and the specific waste handling provisions.

One of the most important aspects of a permit application is the closure plans. The Department wants to be sure that any facility that's active right now in Florida has an adequate plan for closing the facility, removing the waste, decontaminating the structures and the equipment, and finally certifying that this process is done in a proper manner. We also require a contingent post-closure plan for land disposal facilities, where not all waste or waste constituents can be feasibly removed as part of closure. The post-closure plan is designed to ensure that the site remains secure, that the residual contaminants are not disturbed and includes provisions for continued monitoring and if needed corrective action of any releases to the groundwater or the surrounding environment are detected. Both the closure plan and the post-closure plan must include current cost estimates for conducting the closure activities.

The final permitting standard is the financial assurance demonstration. We want all facilities that are going to operate in Florida to demonstrate that they are financially capable of completing closure and post-closure of their facilities. They must also provide proof of liability insurance throughout their operating life.

EPA permits are called Part B permits and they are issued for construction or operation of the facility and for post-closure of the facility. Florida FDER has four different types of hazardous waste permits. The temporary operating permits provide the time frame to bring the facilities from compliance with the 265 interim status standards to compliance with the final 264 standards. Construction permits are for construction and siting of new facilities. Operation permits are issued when a facility can demonstrate that it is in full compliance with the 264 final requirements and all state requirements as well. Closure permits will regulate the final closure of the facility and the post-closure of the facility if applicable. All permits, except for temporary operating permits can last for up to five years. Closure permits and operating permits can be renewed as required.

A brief summary of how FDER reviews and processes a hazardous waste permit application follows. When an application is first received, the district permitting engineer will start to review it. He will also coordinate with the Tallahassee and with EPA permitting staff. The application is reviewed for completeness within 60 days of its receipt. The district, then, prepares a letter to the applicant informing him of any incomplete or deficient items noted during this initial review. This letter requires a 30-day response date from the applicant. The review and resubmittal process will continue until the district engineer determines that a complete and adequate application has been submitted or a decision is made that this facility cannot achieve the standards.

He, then, initiates either drafting of the permit or drafting of the permit denial. The public notice phase then begins. FDER requires the permittee to publish in a newspaper and to broadcast over the radio station of FDER's intent to issue the permit or to deny the permit. FDER then accepts (actually encourages) comments for a 45 day period from all affected parties. The application and the draft permit are available for public review. If an objection is received during the 45 day comment period, the department will schedule an informal meeting at which the applicant, his consultants, FDER representatives, and all concerned parties can discuss and hopefully resolve any conflicts. If the concerns can't be resolved, a formal hearing will be held to resolve all disputes. Pending the outcome of this process, the department will, then, either issue the permit, issue a modified permit as required, or deny the permit and require submittal of a closure permit application.

Currently, the department has received 180 permit applications for about 115 separate treatment, storage, and disposal sites. This is divided up into 87 temporary operating permits, 34 operating permit applications, 45 closure and/or post-closure applications, and 14 construction applications. Out of the 115 sites that have applied, 53 have already elected to either close, are closing, have withdrawn their applications or have been denied a permit by the department. The remaining 62 are divided as follows: 32 active container, tank storage facilities, 19 active treatment operations (only two are incinerators), and 11 land disposal operations.

Permitting activities by the FDER Northeast District Office includes 22 separate sites. Eight of these are for storage (six currently active). Three treatment sites applied for a permit, only one of them is still active. Eleven land disposal units have applied for a permit in this area of the state. All of these are surface impoundments and include four corrosive waste impoundments which are now closed or are closing; one landfill which is now closed and performing corrective action under post-closure; five impoundments that contain toxic metals or solvents, three of these are closing, two are still active; and one wood preserving waste impoundment which is now closed.

Along with hazardous waste permitting efforts, FDER also has an aggressive compliance and enforcement program. All treatment, storage, and disposal facilities in the state are inspected at least once annually. All land disposal operations are inspected at least twice annually. During the site inspection, a checklist is filled out and the inspector notes any violations. The inspector completes a report of his findings noting any violations and immediately classes them by their severity. Violations of hazardous waste rules are referred to the enforcement section where an appropriate enforcement action is drafted. Enforcement actions may include substantial penalties and all will require immediate corrective action. Follow up inspections are conducted to ensure the adequate corrective actions have been performed.

Before concluding, I wanted to mention emergency permits. There are situations which occur in Florida which involve highly explosive and unstable hazardous wastes and these require immediate attention. FDER has therefore established a procedure for handling these situations under the emergency permit rule. When explosive material or material that has decayed and become explosive or unstable is discovered, the FDER will evaluate the situation and review treatment and disposal alternatives. If it is determined that the only acceptable treatment or disposal alternative is detonation, the FDER will review the proposed treatment (detonation) procedures and the proposed treatment site. If the treatment process is approved, the FDER will issue an emergency order which will allow a one time detonation or thermal destruction of the explosive hazardous waste. FDER will provide for after the fact public notification of the activity and invite public comments and concerns which will be used to improve the emergency process. In 1984 when FDER started emergency permitting, only seven permits were issued. In 1985, 17 permits were issued. The number of emergency permits issued is expected to increase in 1986.

Hopefully, as the department issues more hazardous waste permits, the number of enforcement actions for improper hazardous waste management activities and the need for emergency permits due to a lack of acceptable alternative treatment sites will decrease. The FDER hazardous waste staff are always happy to answer your questions and to provide technical assistance to resolve any waste management problems. If you need assistance, please contact your FDER District Office or call the Tallahassee FDER Office at (904) 488-0300.

CURRENT STATE DIRECTIONS AND SOLUTIONS

Raoul Clarke
Environmental Administrator
Bureau of Waste Management
Florida Department of Environmental Regulation

There's an adage, "I'm here from the State and I'm here to help you." It doesn't go over real well. However, I think, in my part of the presentation the state perhaps is here to help you. I hope I can get that across by just letting you know some of the newer programs that we're involved in now. When it comes to questions on what we're doing, I'll tell you right up front I might not have all the answers. I'm not afraid at all to admit we don't have the answer or we're looking at it or we can't solve that problem right now.

I want to talk about the design and implementation of the hazardous waste program. As you heard this morning, the Department of Environmental Regulation's (DER) initial authority in the hazardous waste program was in 1980 and then we just mirrored EPA's regulations because we were all new in the business. In 1983 there was the Water Quality Assurance Act which increased emphasis at the state level. Out of that came the need for public awareness and public education, such as Amnesty Days. What exactly is Florida generating in hazardous waste? How much do we really have? We know who the big guys are. Under the federal program, they have to report to us, we inspect them. But how much waste are we really looking at?.

The Legislature said, "It 's Florida's problem. We are creating, generating hazardous waste in our state. We can't keep sending it out of state." So, the law called for the siting of a large, multi-purpose facility; someplace to send the waste within Florida. After that law was passed, we realized we were almost like Minnesota. We went for the big facility, but what do we need? What kind of facility? What kind of technologies do we need? It was decided that we should conduct more research on large facilities before we build one and hope it works.

In 1985 we decided we needed a systems approach from the local level; collecting the waste, regional storage facilities, and then the large multi-purpose facility. The grants program for collection stations came in 1985. The legislature acknowledged that we have a problem and that we want the facility at the end to take care of the waste in our state that we generate; that's where we want to go. How do we get there? We're conducting studies and trying to find a workable solution.

Public awareness and education programs are fundamental to every problem, especially this problem. Perception is reality. If the public perceives something, it's real. If we perceive hazardous waste is going to be dangerous, then it is. I can stand up here all day and tell you we can collect it, there's technologies to manage it, but if you don't believe it, then it's not going to happen. Perception is reality. We have to change our perception to acknowledge that we have a problem, it can be taken care of, and this is how we plan to do it and need your help. In addition to our state initiatives, the federal government has lowered the limits for small businesses. That brought us also into a lot more educational needs for the businesses which are now regulated.

Has anybody not heard of Amnesty Days? Good. The major purpose of Amnesty Days was for public awareness, to provide free collection, a one time opportunity to remove the waste, show that it can be collected in a residential places without incidence, and then transported and handled properly. I think it's done that. A gentleman stopped me at lunch and said, "You've got to continue that program." I think that's true, but we have to continue the momentum that has started and the feeling that everyone has hazardous wastes which need to be properly managed. The legislature is not going to keep funding free pick-up, but they are going to substitute it with the grants program (which I'll cover later) to try to build a self-sustaining system.

The statistics on Amnesty Days, so far, is 43 counties have participated. There's been 10,626 participants. So far, 1,358,777 pounds of waste has been collected. That's a lot of waste when you consider it's mostly out of our houses, school laboratories and small business set at one drum limit. All of it was collected without incident. I think that's rather important. A few emergency permits were issued when somebody showed up with some TNT and some old ammunition and things like that that we just couldn't put in a drum and take away, so we had to quickly get rid of it. The lack of incidents is very important because these collection centers were set up in shopping center parking lots. The types of waste brought in ranged from restricted pesticides, like DDT and Mirex, to acids and lots of school chemicals.

While Amnesty Days was being conducted, the program of local and regional assessments was attempting to define and get a good data base on the amounts of hazardous waste in Florida. So we hopefully have some public awareness, some momentum, and a lot of data. What are we going to do with it? We have a responsibility to manage the waste properly, to provide a system to collect the waste and get it to proper treatment facilities. We need a network to get it to the treatment facility. Let me start at the other end and come back to local collection. That's where I know there's a lot of interest.

What kind of treatment facility? We've seen a lot of different technologies. What kind of design do we want? How big do we want to build it? Do we want to build it just to handle the amount of waste that we've seen being generated through the assessments? Do we want to overbuild it a little bit for growth? These questions need to be answered before a $100 million dollar investment is made.

Who's going to own the facility? How are you going to build it? How are you going to pay for it? Bonds. General revenue bonds? Pollution control bonds? Industrial revenue bonds? When you get into the intracacies of a project like this, there's no easy answers. To try to address and not rush into this type of program, we've initiated two intense studies. One is on financing and ownership alternatives. Not to answer the questions, but to investigate different avenues within the state constitution, within existing state laws, within the national perspective of getting money. Lending institutions and the ownership questions of: "Does the state want to run this facility? Do we want to ask private industry to come in and build it and operate it and we'll lease property to them? Do we want to go into some kind of partnership as Texas has done?" These are very far reaching questions.

The second study is the system concept study. Hopefully from this study, the financing and ownership study, and any other information we have on waste generation, we're going to know how much hazardous waste we'll be generating, what types of waste we'll be generating, and a fairly sound recommendation on the capacity of the treatment facility will be developed and where it should be in location to the major generation centers within the state, transportation routes in and out to the facility, and the network that's going to bring the waste into the facility.

In the meantime, the facility can take years. With the studies we have planned, it's, I think, 16 months until the recommendations are going to come in from the concept study. Then, the recommendations have to be looked at by the department, the public, and the legislature. The design specifications have to be drawn up and then, finally, you've got to find somebody or way to do it and bring it on line. We're looking at 1990 or 1992. What's going to happen in the interim?

I think that's where we come back to the collection program. To assist in this effort, the legislature appropriated $500,000 for the establishment of local collection centers. This would allow local governments an opportunity to provide the collection station to small quantity generators and, perhaps, households. There's lots of scenarios on how these things could be designed and operated. The legislation also stated that a private concern should be responsible for the collection of the waste and taking it to a permitted facility and in time that the local collection centers could become privately owned and operated.

It's a brand new program for DER. We promulgated administrative rules and the local collection law. Each county can be granted up to $50,000 to build a local collection center. We have no application form. We have no designs that say here you go build this and it's approvable. The rule says that local government can work with the hazardous waste transporter or private concern or within themselves to come up with a plan on how they could get a collection center in operation and then come and talk to us. If it looks like it will work and it doesn't go against any existing state or local rules, great. We are trying to learn from you on what you think will be a desireable and operational collection center.

The $50,000 which is available to each local government, as it stands right now in the legislation, is only for capital outlay and does not include land. The feeling is that if local governments want to have a collection center, they can find a piece of property. It's for capital outlay, such as building a fence around it, paving an area for a truck to pull up and remain for a few days, putting enough fence around it with gates, running power and water, setting up a small shed for an office.

Then, there's the intracacies of local collections; the new small quantity generator regulations, the new manifesting requirements. Who has to actually fill out a shipping paper that accompanies their waste to one of these facilities? Who has to sign it as taking the waste? Even the new definition of who is now a generator. If small business generates this much waste in a month, are they a small quantity generator? If they generate this much, does that make them one? Do they have to do all the manifesting paperwork?

Local collection centers could be state of the art, but you're not going to get that for $50,000 and probably local government won't want to assume the status of owning and operating a hazardous waste storage facility. Why doesn't local government just build a fence behind the fire house and take wastes? Right now, it's only for capital outlay, so you could build your fence. You've got to pay somebody to be take the wastes. You've got to train that person to separate it. Are you going to operate it all day, 8:00 a.m. - 5:00 p.m., or are you going to do it on weekends? Whose going to pick up the waste once you've collected it behind the fire station?

Let's take Amnesty Days one step further. You have $50,000. You've talked to some hazardous waste transporters, you've talked to some trade associations, you've talked with some businesses in town. If local government gets the money, it may have a piece of land that they own, and can build a fence up around it, put a big gate, run power and water to it, and then contract with a hazardous waste transporter to service this site. This is a collection site. By a good campaign and a good awareness program within the county, say once every three months the transporter will come and through contracts with small businesses, he can pick up the small quantity waste and bring it back to his tractor/trailer truck.

The transporter is taking the responsibility for the waste. If there's a manifest that the small business has one drum, the transporter is going to be the transporter of the waste. He's going to accept the manifest. He will, ultimately, take the waste to the treatment or disposal facility. All local government does is provide a site. They're not taking possession of the waste.

Even with this concept, there's intracacies that have to be worked out. Someone from Lake City said that local government is reluctant because if they're the first one to do it, they're going to get all the waste from the other areas. Very legitmate. Nine counties could pool their applications and get with a transporter who could service one county for two days, service the next county, etc. and you've protected yourself.

I don't have the answers. I think we all have to work together. I think the climate is good at the state level and in the legislature. Believe me, the legislature tells us what to do. It's not just DER telling you what to do. The legislature tells us what to do a lot of times. They mandate to the department a lot. We have to site a multi-purpose facility. It's not an easy task. But I think if we work together, trade associations, local governments, and the state, we can probably work something out.

Amnesty Days worked. DER said, "Okay, we're going to make it work. It's never been done before. We'll be the generator." We signed every manifest as it came in as a generator. We took responsibility for all that waste. Citizens brought it in, but we signed off as the generator. It was taken to a permitted hazardous waste site without incident. I think you can do that at a local level.

LOCAL ASSESSMENT AND STATISTICS

Carolyn Voyles
Florida Department of Environmental Regulation
Tallahassee, Florida

As Raoul mentioned earlier, the 1983 Water Quality Assurance Act required DER to coordinate with the regional planning councils and the counties to conduct county and regional hazardous waste assessments. The state legislature appropriated $2.16 million for this task. There are three goals for the assessments: (1) to use the data from the assessments for state programs that ultimately will serve to protect ground water; (2) to involve local governments in hazardous waste issues; and (3) to provide market analysis data to private industries who are interested in hazardous waste management in Florida.

The assessments are phased over three years. So far, 42 counties in eight regions have already completed the assessments. There're marked in colors on the map. The yellow areas shown completed the county assessments by the end of 1984. The areas shown in red completed the assessments last year. Twenty-five counties are left that are currently conducting the assessments. They represent three regions and are shown in white on the map. Basically, these counties are along the Ocala, Gainesville, Lake City, Tallahassee, Marianna corridor. County assessments will be finished by the end of June of this year and the regional assessments will be finished by the end of December.

The assessments are composed of four components. The first component is a survey. The second component identifies uncontrolled or abandoned sites that may contain hazardous waste. The third component describes hazardous waste handling procedures at sanitary landfills. The final component concerns the designation of areas for hazardous waste management facilities; both the counties and the regions have responsibilities in making area designations. Since the survey data and the area designation data are most pertinent to this conference, I'm going to concentrate on those two components.

Starting with the survey: over 103,000 surveys have been sent to potential generators of hazardous waste throughout the state. The surveys identify what kind of hazardous waste is produced, how much is produced, how it's stored, and how it's disposed. The different disposal methods are categorized as to whether they constitute a proper management technique or a technique that requires further management. For wastes that require further management, each county is required to come up with a needs assessment. This shows how much waste would be available if a hazardous waste facility were located in that county.

From the data that we already have, we've been able to make some statewide projections. Before I give any projection information, I want to caution you about the data base. The first caveat is that this is a living data base; it's continually up-dated. The projections are based on data from 42 counties. Once we receive the data from the remaining 25 counties, we will have to up-date the data base. In addition to this, each county is required to verify the hazardous waste management practices of at least 20 percent of the potential generators each year. This means that after five years all generators should have been verified in each county. Reports containing this verification information are due to the department at the end of June. When we receive that information, we have to update the assessment data base.

The second caveat is that the survey data base does not include power plant data, and it does not include the two largest generators in the state. Collectively, power plants generate 2.2 million tons of hazardous waste each year, and the two largest generators in the state produce approximately 1.1 million tons of hazardous waste each year. These entities are regulated. We know these wastes are handled properly; therefore, these waste amounts are not included in the data base.

Taking the caveats into consideration, the survey shows that approximately 300,000 tons of hazardous waste are generated in Florida each year. Fifty-eight percent of this waste comes from small quantity generators. We currently estimate that there are over 25,000 small quantity generators in the state. This means that collectively small quantity generators make significant contributions to the hazardous waste stream in Florida.

Furthermore, the survey indicates that 50.2 percent of the hazardous waste in the state is managed properly. That leaves 49.8 percent which requires further management. The fact that nearly one-half of the waste requires further management shows that we do have a need for hazardous waste facilities in the state.

The survey data also show that of the nearly 300,000 tons per year generated, 93 percent of this waste falls into one of five categories: (1) waste oils and greases, (2) reactives, (3) solvents, (4) heavy metals, and (5) batteries. Note that waste oils, solvents, and batteries are all able to be recycled. Although, we have the technology to recycle these materials, the problem is how to get these services to the smaller generators.

As for the area designations, each county is required by state law to designate at least two areas where a hazardous waste storage or transfer facility could be located. To date, 88 areas have been designated among the 42 counties. In addition, each region has siting responsibilities. The regional planning councils must designate at least one site where a hazardous waste storage or treatment facility could be located. To date, 25 sites in eight regions have been designated as regional sites. These are also marked on the map.

The survey data and the area designation information will help the state further its plan for a systems approach to hazardous waste management. We know that we have the waste and we have to collect it.

WASTE REDUCTION, REUSE AND RECYCLING

PROVEN PROFITS THROUGH POLLUTION PREVENTION:

CONCEPTS, APPROACHES, AND RESULTS

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ABSTRACT

For two decades industrialists and regulators have asked what do we do with pollutants to keep them from contaminating the environment? The answers have produced laws that require costly pollution control processes and, all too frequently, just transfer the pollutant from one medium to another. It's little wonder that many people have come to believe that preserving environmental quality and making a profit are in fundamental competition with each other—an either "jobs" or the "environment" dilemma.

Fortunately, leading industrial innovators throughout the world have decided that we are coming up with answers that satisfy no one because we are asking the wrong question. The main question should not be what do we do with pollutants, but how can we prevent or minimize the pollutants we create? If we don't create the pollutants in the first place, we don't have to worry about what to do with them. Like many other truths, this one is so simple that it was overlooked for a long time.

Now that we are finally asking the right question, we are finding that preventing pollution is not only technically sound and ecologically beneficial, it is also profitable for firms and their employees—POLLUTION PREVENTION PAYS.

HOW CAN POLLUTION BE PREVENTED?

Industries that have been successful in preventing and minimizing pollution, take two basic approaches: (1) they perform an audit of their operations to find out exactly where the raw materials are used and where they are turned into waste;

and (2) they encourage their workers to direct their creative, problem-solving abilities to developing pollution prevention approaches for their company, and they reward them when they are successful.

As information and data are obtained through the above initiatives, the changes put into practice usually include one or more of the following.

HOUSEKEEPING - Many firms find that as they obtain more accurate information about their wastes, they can take housekeeping measures to reduce the waste of valuable raw materials. Among those housekeeping changes are (1) recycling the previously wasted materials back into the manufacturing stream, or using them in some other process; (2) keeping non-hazardous wastes separate from hazardous wastes; (3) replacing leaking gaskets, valves and pipes; (4) performing general, preventative maintenance more frequently and more thoroughly.

SUBSTITUTING MATERIALS - Some firms modify their process to substitute a less toxic substance for the previously used toxic material. In some cases, organic solvent-based materials are replaced with water-based materials. This conserves valuable non-renewable petroleum resources, reduces the workers' exposure to potentially dangerous vapors, and lessens the long-term liability for the firm because the potential for groundwater contamination is reduced. Frequently, the shift to water-based materials lowers the cost of raw materials.

REDESIGNING EQUIPMENT AND OPERATION - Some firms find they can reduce waste production by redesigning their equipment and its operation.

RECYCLING AND REUSING - Industries are saving money and protecting the environment by recycling their solvents and in many cases, their metals, in their own plants. Others use off-site recyclers to reduce waste production.

WASTE EXCHANGING - One company's waste is another company's resource. Waste Exchanges are providing a network for negotiating exchanges of wastes—and saving money for both companies.

A number of processes are used to recycle, separate and detoxify wastes, including the following:

DISTILLATION - An array of distillation approaches can recover solvents, and the process pays for itself in a very short time in reduced purchases of virgin solvents and reduced solvent disposal costs.

ADSORPTION-ABSORPTION - Dilute concentrations of gaseous materials or materials in solution can often be concentrated economically through adsorbing or absorbing the compound. Later that compound is desorbed in a greatly concentrated and frequently reusable form.

FILTRATION, ULTRA-FILTRATION AND REVERSE OSMOSIS - A wide array of filtration approaches and materials, now available on the market, can be used to recover many valuable materials.

ION-EXCHANGE - Ion-selective exchangers are being used to clean-up process water and other solutions, thereby saving raw material, water and energy.

ELECTROLYTIC RECOVERY - Firms using metals such as silver and copper are finding that electrolytic recovery saves money.

MICROBIAL DETOXIFICATION - Microorganisms are being used to detoxify an array of complex organic compounds.

INCINERATION - After all other approaches have been used, frequently organic residues still remain. At that point some type of thermal destruction approach is used to detoxify the substances, reduce the volume and use the material's energy.

WHO IS TRYING THESE CHANGES AND WITH WHAT RESULTS?

Below are five examples of corporations who have applied the above pollution prevention strategies in their operations:

Daly-Herring Company, a pesticide formulator of Kinston, N.C., altered its dust collection equipment so that waste streams containing hazardous organic chemicals are now collected separately. The collected materials are no longer contaminated by alternate waste streams, and each is recycled back to the generating process. Waste reduction: 45,000 lb./year. Net Cost Savings: $11,638.

Stanadyne, Sanford, N.C., systematically reviewed their electroplating processes and made the following changes to reduce waste:

1. substituted a sulfuric/peroxide material for chronic acid and reduced sludge produced in the parts cleaning operation
2. began operating their copper and chrome plating baths at lower concentrations and saved both raw material and sludge handling costs
3. redesigned equipment and made operation changes which reduced dragout volumes and rack recoating costs and improved plating efficiency
4. installed tanks before the rinsing operation to recycle valuable metals back to the plating baths
5. changed the plating bath filtration equipment operation and drastically reduced solution losses and reduced filter medium required by 93%
6. added a filter press to efficiently dewater the sludge, reducing weight and volume of sludge to be transported
7. made housekeeping improvements to eliminate leaks and added a pre-inspection program to prevent plating defective parts
8. in a recent plant expansion, their pollution prevention goals led to selection of a new degreaser that significantly lowered solvent use. Stanadyne established "quality circles" to promote pollution

prevention within their plant. Stanadyne has set the pace for electroplaters throughout the country.

3M Developing Plant, Columbia, MI., installed a decanter system that provides gravity separation of the 1, 1, 1-trichloroethane from the water to recycle the solvent and meet process water discharge regulations. Annual savings: $12,000.

Vulcan Automotive Equipment Ltd., Vancouver, B.C. modified the cleaning process in their automotive engines refurbishing business to replace the inorganic caustic cleanser with a high velocity "aluminum shot" system. The change increased productivity, improved the final product, reduced health risks to the workers and eliminated the production of hazardous wastes completely—all by-products are recycled. Annual savings: $40,000.

Data General Corporation, Clayton, N.C. launched a vigorous program to reduce their reliance on hazardous waste landfills. They developed markets for their untreated wastes, and made other wastes suitable for sale by treating it with new process chemistry and making some changes in equipment design and operation. Data General's program to produce saleable wastes has reduced the hazardous material they landfill by over 400 tons per year. Annual savings: $180,000.

RECYCLING IN NEW JERSEY

AN ELEMENT IN THE STATE'S SOLID WASTE MANAGEMENT PLAN

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In the 1970's, New Jersey had about 100 operating landfills that accepted almost 90% of all the waste dumped in the State. Today there are 10 major facilities remaining and some of these are at or near capacity. Disposal costs have increased from a statewide average of $3.00 per ton to more than $30.00 per ton in some areas of the State. Some communities who have been required to landfill out of State are paying tipping fees of $65.00 per ton.

Changing the way we manage solid waste and the siting of new disposal facilities is a critical issue in the State. It is, therefore, important that recycling of materials be incorporated as part of the State's strategy for solid waste management.

A STATEWIDE RECYCLING PLAN

In 1980, in recognition of the need to include source separation and materials recycling as part of the State's comprehensive plan to manage solid waste, the Department of Energy and the Department of Environmental Protection formed an advisory committee to develop a statewide recycling program. Within six months, the committee, represented by persons from state and local government, environmental organizations, and business and industry presented a plan to the two departments. Based on markets and material availability the Recycling Advisory Committee recommended that the State set a goal of recycling 25% of the municipal waste stream or about 1.5 million tons annually of paper, metal, glass, plastic, rubber and organic waste material.

The 25% goal was to be achieved through the State Recycling Act which was drafted in 1981 and signed into law in September of that year. P.L. 1981, c. 278, the New Jersey Recycling Act (effective January 1, 1982), provides a grant and loan program through a $0.12 per cubic yard surcharge on all waste landfilled in New Jersey. This fund raises about $4 to 5 million a year and the "Act" stipulates how the fund must be spent:

45% is allocated to municipalities based on the tons of material recycled each year from residential, commercial and institutional sources in their community.

20% is allocated as low interest loans or loan guarantees to recycling businesses.

15% is provided for education programs.

10% is the maximum allowed for State administrative expenses.

10% is allocated to counties and municipalities for program grants.

THE TONNAGE GRANT PROGRAM

By March 15th of each year municipalities submit to the Office of Recycling applications documenting the tons of material collected for recycling from sources in their community. Documentation includes letters or receipts from the recycling market, or in the case of leaf recycling certified information from the municipal office responsible for collecting and managing a leaf recycling program. In the first year of the program (1983) 240 of the State's 567 municipalities documented the recycling of about 260,000 tons of material. In 1984, 298 communities participated and received funding for 490,000 tons. The 1985 review indicates that 340 applicants documented more than 620,000 tons of material.

The dollars each municipality receives depends on the eligibility of the material claimed and the total amount actually documented. In 1983 each ton was worth about $8.00. Due to a requirement in the law for distribution of the fund by certain materials based on increases in recycling the amount per ton was variable in the second program year. However, through a 1985 amendment to the "Act" this requirement has been deleted and communities are once again paid for the total claim of eligible materials documented to the State. The '85 grant ranged between $4.00 and 5.00 per ton. In addition the Office of Recycling is authorized to provide bonus grants for high recovery rates. This rate is currently being defined and grants will not be available until the end of 1986. As of December, 1985 municipalities received over $7,000,000 from this fund.

THE RECYCLING LOAN PROGRAM

The Office of Recycling has reviewed more than 30 requests for low interest loans. The interest rate is tied to prime and is currently 6%. Businesses seeking to expand or establish new recycling activities in New Jersey are eligible to apply for a loan. The application is submitted to the Office of Recycling on forms provided for that purpose. The project is reviewed by the Recycling Office and a recommendation is made to the Commissioner of the

Department as to the acceptibility of the project. If an affirmative determination is made the project is then referred to the New Jersey Economic Development Authority (EDA) for financial review. Once the application is reviewed by the EDA a final recommendation is made on funding. To date ten loans have been approved. Some of the funded projects include: glass recycling equipment, production of new products by recycling PET and other plastic material, high density baling equipment to meet the demand of the export paper market, and expansion of a tire retreading operation.

RECYCLING EDUCATION AND PROMOTION

The Office of Recycling through a contract with a public relations and advertising firm, Holt and Ross, Inc. , conducts a statewide education and promotion campaign on recycling. The working symbol of the program is Mr. R.E. Cycle , a magician who is not only a cartoon character for printed material and logos but also a real live magician who presents the recycling message to hundreds of children throughout New Jersey's schools. The program includes television and radio announcements, billboards, seminars for businesses, publications and presentations at fairs and other regional and statewide events.

In addition to the promotion campaign the Office of Recycling provides technical assistance programs, two seven week courses for municipal officials that must operate programs, a recycling market directory, case studies of various local programs, and other types of publications as well as grants to municipalities, counties and non-profit groups to educate the public on the specifics of local programs.

PROGRAM GRANTS

Over the past three years the Recycling program has provided over a million dollars to municipalities and counties to purchase collection equipment, construct multi-material processing facilities, hire recycling coordinators and to perform other recycling activities. It should be noted that out of the 567 municipalities in New Jersey more than 430 have recycling programs and of this number 159 are mandatory, many of which are multi-material curbside collection programs.

MARKETS

New Jersey is fortunate to have a network of secondary material industries, including over 90 dealers who process materials prior to shipping to mills or plants that make new products from recyclable material. In the State there are nineteen (19) paper mills that make such products as newsprint, boxboard, insulation, wallboard and toilet tissue, seven (7) glass plants that use cullet (recyclable glass) to manufacture new containers or insulation material, and two (2) steel mills that melt old metal into new products. Its location on the east coast also places New Jersey at an advantage in the export market. More than 500,000 tons of waste paper accounted for the largest shipment of goods leaving Port Newark last year.

Since the program began in 1982, New Jersey has seen the following recycling business expansions:

> Alcoa Alumnium opened up a scrap aluminum can processing facility in 1985 in Edison. This facility the largest of its kind is designed to serve 12 States in the Eastern region.
>
> In 1985, Brockway Glass developed a glass intermediate processing facility to expand their purchase of cullet from recyclers.
>
> Garden State Paper Company over the past few years expanded their network of buyback centers for a supply of news for their plant in Garfield.
>
> General Engines Co. of Clayton designed collection equipment that several towns in New Jersey now use for their curbside source separation programs.
>
> Pace Glass expanded from metals recycling to glass recycling to service the Jersey City area.
>
> Zozzaro Brothers expanded their paper processing capacity in Clifton and installed through a low interest loan an improved baling system.
>
> Glass Cycle Systems began glass recycling programs in large taverns throughout the State and have expanded into municipal services.
>
> Filpat Manufacturing Co. of West Windsor produces fireplace logs from organic waste and polyethylene plastic wastes and has expanded into production of other products from waste plastics.
>
> Lobosco and Sons in Passaic County increased its processing capacity with a low interest loan to handle more waste paper.
>
> Kohlbrenner Scrap Metals in Burlington has expanded operations to service municipal as well as commercial generators of waste glass and metal materials.
>
> GRR Corporation, a joint venture of a Camden County scrap processor and a Connecticut glass processor, was formed in the City of Camden to develop with the County an intermediate

processing facility. This facility is designed to provide an outlet for the materials collected by Camden County municipalities. In Camden County all 37 municipalites mandate source separation programs.

EXECUTIVE ORDER 57

In December of 1983, Governor Kean issued Executive Order 57 requiring all State agencies to recycle at a minimum office waste paper. He charged the Office of Recycling with the responsibility to see that his order was carried out. Presently all 20 State Departments have begun the process of separating high grade office paper from other waste material. This has diverted about 600,000 pounds of material from the landfill, produced over $16,000 in revenues and saved about $15,000 in disposal costs. The program is expected to expand as the departments bring all their agencies on line.

OCTOBER REPORT TO THE GOVERNOR AND LEGISLATURE

P.L. 1981, c.278, required the Office of Recycling to submit to the Governor and Legislature a report on the State recycling program by October 1, 1984. That report essentially outlined many of the acivities described above. The Office also presented a list of recommendations for change, one was to expand the State program from a voluntary system to a mandatory one. This recommendation was supported by the Governor in his 1985 State of the State message.

At that time, he announced his commitment to developing legislation to bring about a Statewide Source Separation and Recycling Act. The legislation which incorporated many of the other recommendations of the Office was introduced in March, 1985 (Assembly Bill 1781 and Senate Bill 1478). The highlights of the bills are as follows.

25% GOAL: WHAT IS MANDATED?

Since the market is readily available for all the containers we can generate, the recycling of aluminum beverage containers is mandated. In addition leaves are required to be recycled through composting or mulching programs by placing a ban on the landfilling of leaves from September 1 to December 31st of each year. Within six months of enactment of the law, counties working with their municipalities will be required to develop a county recycling plan. The plan must identified at least two other materials that will be required to be recycled by communities in each county. The designation of these other materials is contingent on the counties or municipalities reaching agreement with the markets for the disposition of those materials. If the local governments fail to find markets they may apply to the Department of Environmental Protection for an extension or temporary exemption from the two material requirement. If the Department determines that such a request is valid it may grant an exemption for up to one year. The bills also require municipalities to include recycling plans in land use proposals for 50 residential units and 1000 square feet or more of commercial or industrial projects.

PACKAGING AND OTHER PRODUCTS

As solid waste management in the State changes to include a significant recycling effort, packaging creates a problem through its unidentifiable component materials and its constant change. The displacement of highly recyclable packaging such as glass and aluminum by plastics and bi-metals serves to increase the amount of material that must be landfilled. It also reduces the market share and economic viability of companies that manufacture recycled containers. Plastics are a particular recycling problem because of lack of adequate end-use markets and the economics of collecting them in curbside source separation program.

Plastic:

Although New Jersey has over 430 municipalities with recycling programs that collect a variety of materials, only one community collects plastics. Plastics are increasing in the waste stream and are only recycled in any quantity where States have instituted beverage deposit legislation. Curbside collection of this material has not proven to be economically efficient because of the volume of space required to handle such a low value material. Municipalities are generally not equipped to bale and store the quantity required for economic marketing.

The proposed legislation therefore recommends that the plastic industry be given eighteen months to develop a collection and recycling system for plastic containers of 12 ounces or more. If this does not occur, a surcharge will be placed on these containers to provide for a collection and recycling fund.

Bi-metal Containers:

There is also no recycling system in New Jersey for bi-metal containers. Soft drink and beer companies, in response to economic conditions, sometimes switch from packaging in aluminum cans to packaging in bi-metal containers. This creates a problem in recycling programs designed to recycle aluminum containers. The bills recommends a deposit on bi-metal containers to effect a change in their use.

Labling Containers:

Plastic containers and metal containers will be required to be labled as to their recyclability or non-recyclability and their content. This will assist in reducing contaminants in the recycling stream of packaging that is not easily identifiable.

Tires

Approximately 5 to 7 milllion scrap tires are generated in New Jersey each year. Tires are a difficult material to landfill, if a landfill will accept them at all. They are also a litter problem and illegal disposal problem. The proposed legislation requires that a surcharge not to exceed $3.00 be placed on the sale of tires to provide for a recycling program and proper disposal if such a program has not be developed within two years.

FUNDING

The proposed Source Separation and Recycling Act will be funded through a $2.00 per ton landfill surcharge which is expected to raise about $20,000,000 a year. The fund will be distributed as follows:

35% - research , low interest loans, and market development programs.
35% - municipal tonnage grant program
15% - education and promotion program
8% - County program grants
7% - State administrative costs

MARKET DEVELOPMENT PROVISIONS

Procurement:

Procurement by the State over the next four years of increasing percentages of recycled products, including paper, retread tires, construction materials (asphalt, rubber, paper, and glass), and re-refined oil. The products purchased will be determined by the use and their availability.

State Tax Incentives:

20% investment tax credit against an industry's state corporate business tax for the purchase of recycling equipment and investment in recycling businesses.

Industry's that manufacture products using 50% or more post consumer waste materials will be allowed to deduct 100% of their energy costs from their net income that is taxable under the State Corporate Business Tax.

Products made from 50% or more postconsumer materials will be exempted from the State sales tax. In addition beverages packaged in recycled containers will be exempted from the State sales tax or wholesale alcohol beverage tax.

STATUS OF THE LEGISLATION

Assembly Bill 1781 and Senate Bill 1478 are very comprehensive and complex pieces of legislation. They identify many of the problems of changing solid waste management practices from disposal systems to recycling programs. They also establish some of the solutions to the problems. The total solution will require a partnership between industry and government, as well research and marketing programs that not only provide expanded recycling but that also address the development of new products and the impact such products have on solid waste and recycling programs.

Three public hearings have been held on the bills. It is anticipated that Committee hearings will be scheduled shortly and the bills sent to the legislature for a vote this summer.

RESOURCE RECOVERY STATE-OF-THE-ART

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ABSTRACT

The Institute for Local Self-Reliance (ILSR) has been evaluating resource recovery plants for 15 years. ILSR focuses on the economic development potential for urban economies based on waste material utilization. ILSR also conducts state-of-the-art research on dioxin/furan, acid gas and particulate emissions, and leachate from ash residue.

This paper provides readers with a clarification of resource recovery technologies, challenges and opportunities for city, county, and state governments; and recommended guidelines for solid waste incineration.

I. DEFINITION OF TERMS

In order to conduct a useful dialogue on solid-waste management, a definition of terms and their contexts is needed. Indeed, a review of recent literature indicates that the jargon of the field is not keeping up with the rapid development of technologies and enterprises.

The following terms are described here: source separation, waste utilization, mass burn, pre-processing, refuse-derived fuel, composting, and co-composting.

SOURCE SEPARATION

Source separation is recycling. It is the collection and processing of materials. It is also the management of household and business waste so that materials are not mixed or contaminated. Thus, their resale and reuse are facilitated.

Source separation was second nature to Americans until the 1950s. America's oldest tradition, the quilting bee, was a recycling institution with the obvious social setting in which scraps of materials were reused.

California contributed greatly to the rebirth of recycling in the late 1960s. Cliff and Mary Humphrey walked through the state in 1968 founding the country's first environmental action organizations that were based on the recycling issue. Out of this wholly grassroots effort, in which women played the principal roles as technical planners, policy organizers, and site managers, grew viable recycling programs and enterprises which now dot the landscape. Industry merged with grassroots organizations to form the first state recycling association in the nation in 1975, the California Resource Recovery Association. In 1978, California passed the country's first litter tax. It was a model for capital acquisition for recycling programs. This law emerged as a legislative compromise on the "bottle bill" issue. It has since been terminated under its "sunset" provisions. California state agencies such as the Solid Waste Management Board and the Office of Appropriate Technology were the first to integrate recycling into overall solid-waste management planning.

Once stimulated, other states have developed even more extensive programs. Currently, New Jersey, Oregon, and Massachusetts have implemented comprehensive tax, grant, and technical assistance programs totaling $100 million. Michigan and Pennsylvania are among the more recent states to adopt such programs. Among the more innovative municipal programs are: San Francisco; Los Angeles; Chicago; New York City; Boulder, Colorado; Mecklenberg County, North Carolina; Minneapolis; Austin, Texas; Champaign-Urbana, Illinois; Philadelphia; and Newark, New Jersey.

Source separation is fundamental to every subsequent form of solid-waste management. Proper recycling, which is based on convenience to the household and hauler and on the concept of "recycling literacy" in our public education system, reduces the cost of waste management and reduces the flow of waste to landfills and incineration plants. Hence, pollution is prevented. Several recycling "cook books" have been prepared by recycling pioneers such as Cliff Humphrey, Rick Anthony, Tania Lipshutz, Bernie Meyerson, Gary Peterson, Trish Ferrand, and Pete Grogan.

A major issue now in the field is whether or not to make recycling mandatory, thereby increasing participation and reducing costs. Not all recyclers support mandatory recycling. Some industries are directly opposed to it for fear that subsidized programs will flood the market and destroy private sector activity in secondary materials.

Traditional solid-waste planners expect recycling to pay for itself or be discontinued; yet, careful documentation of recycling programs shows that recycling is cheaper than solid-waste collection and disposal when all costs are accounted for. No waste management system ever pays for itself -- we pay taxes and/or fees to subsidize waste management.

In monetary calculations of recycling, the "avoided cost" value of the materials (what it would cost to haul and landfill or burn garbage) is invariably greater than the positive value (the average value of a ton of recyclables is $20). Markets are available if the general community recycles. For example, in Philadelphia, small recycling centers could not market materials. Since the city announced its recycling program and hired a professional coordinator, paper and glass industries have put up $750,000 for processing plants to be run by community organizations. The industries have guaranteed to purchase all materials generated in the city. Similarly, cities that start composting programs invariably find markets for compost.

Some recycling advocates have attacked refuse-derived fuel (RDF) for fear that it will make recycling unnecessary. "Why source separate if machines will recover the materials?" In fact, recycling saves an RDF system from $4 to $8 per ton in operating costs. It also saves tip fees. High levels of recycling can actually eliminate entire process lines. Also, recycling yields more valuable, high-quality unmixed glass and plastic. As a resource base, a larger variety of factories can be located in a city where high-quality recycled materials are regularly available. Recycling is also important because it instills values and consciousness in today's generations for whom recycling is no longer second nature.

Recycling is quite valuable as a pre-processing method for mass burn as it reduces tip fees, saves up to $11 per ton in operating costs, greatly reduces ash residues, and can reduce capital investment.

WASTE UTILIZATION

Waste utilization is the end use of recycled materials to produce a new product. While recycling and processing rarely make a profit, waste utilization is usually very lucrative because of the value added to the raw materials. Waste utilization and recycling must be integrated. In Fresno, the operation of a cellulose insulation manufacturing plant in 1978 stabilized the price of newsprint paid to recyclers at $32 per ton. Prior to that time, prices fluctuated wildly from $0 to $45 per ton.

During the last few years the waste utilization field has experienced a plethora of activity. Plastic manufacturers are producing industrial products from used plastics. A mixed plastic manufacturing technology is about to come on line. PVC, PET, and film plastics are now being used by manufacturing plants. These plants are being sought by cities as an outlet for plastics other than landfills and incinerators. Crumb rubber derived from old tires is being used to manufacture industrial products. One manufacturer in Minnesota could not get enough crumb rubber and is now building its own crumbing plant.

Organic matter is also being processed for end use. Berkeley, California is a pioneer in the municipal composting field. Now cities throughout California have landfill composting components, a process being rapidly replicated in Winston-Salem and Mecklenberg County, North Carolina and in numerous towns in Wisconsin, Minnesota, and Florida.

MASS BURN

This disposal technology is 100 years old. The technology and controlling emissions from mass burn plants has improved considerably. Still, even with the best available control technology (as adopted by California and New Jersey) pollution problems from these plants continue. 1/

The sulfer dioxide limits for the Westchester, New York plant had to be extended to 80 percent of the available load under the "bubble" concept. For the North Andover, Massachusetts plant the state is being asked to do likewise. The biggest fear is of dioxin and furan emissions. In Europe, national environmental agencies have identified municipal waste incineration as the prime source of dioxin in the atmosphere. The widespread finding of dioxin in human fat tissues, particularly concentrated in mother's milk, led Sweden to implement a moratorium on waste incineration plant permits for one year as of December 1984. This moratorium was extended in December 1985. Most recently, industry reports indicate that the moratorium will be lifted in May 1986, as the Swedish government has set a 10-nanogram-per-cubic-meter emissions limit for dioxin. Circulating fluidized bed boilers and three stage incineration boilers are said to come under this limit.

A large body of scientists feel that the understanding of how dioxins are formed and how they can be controlled is not complete. Many European governments and several U.S. state governments have developed ongoing testing and research programs to help answer remaining questions pertaining to public safety.

Potentially, mass burn is the most polluting technology because it burns 100 percent of the waste. (Certain RDF plants pollute more than comparably sized mass burn plants because of poor operating conditions.) A 30 to 40 percent ash residue is expected. This waste could be toxic, and California requires that each batch be tested before designating its final disposal. In general, air pollution testing procedures are not adequate and often are not conducted at all. 2/ Interviews with selected residents living near mass burn plants indicated problems with soot, noise, and ash residues.

Mass burn technology is heavily promoted. Yet mass burn plants have been rejected in most areas where a full and open discussion of options is conducted. Indeed, industry spokespeople now claim that keeping information from the public is a necessary condition for getting a mass burn plant approved. 3/ Mass burn plants are also the most expensive form of waste incineration, requiring about 15 percent more capital than other incineration systems. Further, most plants in the United States have needed multimillion dollar retrofits, making these not the proven technologies they are promoted to be.

Plants have also been vulnerable to the drop in the price of oil. In Westchester, New York, $6 million and $9 million have been needed to cover lost energy revenue in 1984 and 1985, respectively.

PRE-PROCESSING

By pre-processing incoming waste using trommels, shredders, and other devices, approximately 15 to 25 percent of the waste, such as metal, rocks, and grit, is removed prior to incineration. This process has a remarkable impact on incineration technology, as documented in Gallatin, Tennessee. European studies also confirm these findings. 4/ However, pre-processing systems are not free of problems. For example, systems in Niagara Falls and Albany, New York and in Columbus, Ohio have not performed well environmentally or financially.

REFUSE-DERIVED FUEL (RDF)

This process is distinguished from pre-processing in that it is a comprehensive treatment of the waste stream to recover a number of co-products, one of which is an industrial fuel. Metal and glass are removed; organic waste for composting and several kinds of plastic are recovered. While a pre-processing system takes out 15 to 20 percent of the waste, the range of waste removal prior to combustion for RDF systems is from 35 to 55 percent. Since, on a pound-for-pound basis, burning RDF and garbage in a mass burn plant emit the same level of pollution, the RDF system pollutes less because it burns less. It also burns prepared fuel, which has a higher consistency and a higher BTU value than garbage burned indiscriminately (an average of 6,200 BTUs per pound for RDF and 4,800 BTUs per pound for mass burn.)

RDF can be incinerated in existing coal and oil boilers as a supplemental fuel. Thus, a community may not need to build a waste boiler. In Philadelphia, the total capital cost for a RDF system is $240 million. Of this total, $200 million is estimated for the boilers while only $40 million is estimated for RDF production.

Perhaps of greatest importance, and another potential cost saving aspect, RDF does not have to be burned to be productive. It can be used as a bulking agent to compost municipal sludge. It can be processed into secondary pulp for domestic and/or international markets. (Technically, RDF is not pulped. Rather, a pulping component is substituted for the RDF component.) If current commercialization efforts succeed, the RDF can be hydrolized for ethanol fuel production. These alternatives offer communities a way out of the incineration dilemma and are less expensive than incineration systems.

RDF systems today are a second generation technology. Plants tried in the 1970s failed for technical, economic, and legal reasons. Today, U.S. plants have over ten years of successful operation. In processing, economy of scale is reached at about 400 tons per day. That is, you do not need larger plants to reduce per ton operating costs. Plants have operated on an economically viable basis at less than 100 tons per day. The most sophisticated plants that recover plastics and produce a final RDF product are most economical at the 500 to 800 ton per day range.

COMPOSTING AND CO-COMPOSTING

Municipal waste composting refers to the processing of mixed waste through a variety of composting techniques -- windrow, static pile, in-vessel -- to decompose organic materials to produce a clean end product. Co-composting combines municipal waste with municipal sewage sludge during composting.

A number of European and U.S. vendors are offering systems which recover nonorganic fractions and compost organic fractions, leaving about 30 percent of incoming waste as residue for landfill and/or incineration. Costs for composting range from $20 to $30 per ton, including capital and operating costs. Cost can be reduced by 25 percent if co-composting is included because of increased tip fees. The estimates assume no revenue from compost sales. In fact, based on the trace amounts of nitrogen, phosphorus, and potassium, compost has a value of $4 per ton as a fertilizer. Current prices in the Midwest and East Coast are between $5 and $12 per ton.

As explained by Dr. Mel Finstein of Rutgers University, it is the rate of decay that makes or breaks a system. Maximum rate systems reduce odors and storage and processing costs. Finstein points out that the compost processing approach is the pivotal point in waste management. Once this step is done correctly, other process and end use options become available. 5/

Successful marketing can be accomplished with planned approaches and quality control. According to Dick Ryan of Compost Systems, Inc. of Cincinnati (perhaps the most succesful compost marketing company in the country), cities have internal markets (roadways, hydroseeding, fertilizer bases) in addition to the private markets (greenhouse and nursery industries, golf courses). Ron Albrecht of Recovery Associates, Inc. of Annapolis, Maryland, suggests that financial planning assumes tip fees as the sole revenue. As revenues from increased marketing accrue, a 50/50 split between system operator and city is suggested.

Marketing of compost is well established in Europe. There, compost/RDF systems are in vogue as an approach to minimize waste incineration. Over 200 plants have been built in West Germany and France in the past five years according to Dr. Eliot Epstein of E&A Consulting, Stoughton, Massachusetts.

Composting and co-composting still face prejudice in the United States; but, proven sludge, municipal waste, and co-composting facilities in Akron, Ohio; Baltimore; Wilmington, Delaware, and numerous small-scale pilot plants in the Midwest are rapidly changing attitudes. Similarly, the rising costs of landfill and incineration systems are directing many planners to explore the composting and co-composting alternatives.

II. CHALLENGE AND OPPORTUNITY

Focusing attention on the problems of solid-waste management may allow for creative solutions. Indeed, new information from industry may provide for consensus planning.

Mixed-waste processing vendors are offering combinations of RDF, composting, and material recovery systems which allow communities to greatly minimize and even avoid incineration under certain circumstances. Such systems reduce environmental and financial risks. Prudent planners should explore these options before committing themselves to a large-scale resource recovery facility. In other words, incinerating municipal waste may not be as necessary as previously thought. Incineration can result in irreparable harm to the environment and can endanger the lives of the very young and the very old and infirmed who are most vulnerable. Incineration also destroys raw materials which can be the basis for economic and community development within urban ghettos. In a similar vein, an alternative approach to solid-waste management will preserve a region's bonding capacity for other needed programs.

The technologies appear to be at hand for non-incineration methods of waste management. These technologies are cheaper to build and operate. They are based primarily on private sector firms and private capital, although local governments play a critical role in providing the financing packages and in monitoring all solid-waste management programs. Business arrangements have been established among system vendors and community development entities calling for equity status and community participation in project design and implementation. For example, one vendor/community package calls for up to 40-percent equity for community development corporations and youth organizations.

Of equal importance to the financial and community development attraction of non-incineration methods is that they help build consensus where internecine disputes between local jurisdictions and citizens are the current norm. In New Haven, Providence, and Philadelphia, early citizen participation in planning has been the key to more efficient and safer systems, as well as to harmonious implementation.

Planners may want to examine the recycling and resource recovery program recently adopted by East St. Louis, Illinois. As stated by Mayor Carl Officer:

> We chose a recycling/RDF/compost technology because it not only solves the waste problem but gives our business community and youth organizations a chance to create wealth from the glass, plastic, and organic matter. Factories will be built in East St. Louis as a result of this system.

In addition, East St. Louis is spared the burden of unnecessary debt. East St. Louis has issued bonds for $125.3 million to acquire, on a turn-key basis, from 2,400 to 3,200 tons per day of municipal waste processing capacity. This enterprise will earn the city revenues from receiving other cities' municipal wastes. RDF produced in the facility can be sold as a fuel or the system can be altered to produce paper pulp for sale to industry. Alternatively, the paper fraction could be composted.

East St. Louis is depending upon technological and market flexibility to get it through its solid waste and economic development problems of the future.

WHAT IS THE DOWNSIDE RISK OF THE MINIMAL OR NON-INCINERATION APPROACH?

Current energy demand in the United States is growing in direct proportion to the growth of the gross national product, roughly three percent per year. Thus, the market for waste incineration can be assumed to be reliable and known. Non-incineration technologies must be able to offer reliable markets for their products. This comes down to what will be done with compost and paper pulp. Experience demonstrates that compost from wastes can be integrated into agriculture and that pulp and paper can be integrated into existing markets.

In this country, city self-use (roadways, golf courses, parks, landfill) and targeted private sector markets (greenhouses, nurseries, hydroseeding, landscaping firms) are potential interim markets for compost while agricultural markets are developed. Paper pulp and paper-making capacity can be fit into domestic and overseas markets. Government procurement policy is critical to stimulate demand for secondary paper products. Gradually introducing these compost and pulp products into the market is also a key strategy.

These market strategies will take great effort and cooperation between government and industry and ultimately the consuming public. Yet they offer the opportunity to alleviate the most taxing air pollution and siting issues for solid-waste management decision-making. Not surprisingly, dramatic changes in disposal costs are catalyzing entrepreneurial and technological dynamism as new firms seek a piece of the $100 billion national garbage disposal market.

HOW MIGHT STATES, COUNTIES, AND CITIES TAKE STEPS IN THIS DIRECTION?

The following list of suggestions is offered:

- special investment tax credits for non-incineration technologies
- bond issues for non-incineration technologies
- vendors' conferences of non-incineration technology systems

- bond issues for commercializing recycling and end uses for targeted materials -- rubber, plastic, organic matter -- including: loan guarantees, low-interest loans, price supports

- government procurement of products with secondary materials content

- government and industry procurement of "homegrown" raw materials and products

- re-analysis of public utilities rate setting guidelines to integrate incentives for collecting recyclables (e.g., variable can rates)

- development of source separation recycling programs

Preliminary to these steps is building a statewide consensus that least-incineration technologies are preferred. From this decision, all other creative policies follow.

III. WASTE INCINERATION

Incineration of waste should be minimized as far as possible using source separation, composting, and preprocessing technologies.

When waste incineration (mass burn or RDF) is required, public health risks and financial risks require high combustion efficiency, multi-staged incineration, exhaust gas recirculation, acid gas scrubbers, fabric filtration, a bag house (with 150 percent of name plate capacity), constant monitoring of the boiler and air pollution equipment, and proper ash disposal (probably in hazardous waste landfills).

These conclusions are based on the following factors:

1. Excess-air type mass burn incinerators usually do not have as high a combustion efficiency as multi-stage controlled air incinerators that can burn either MSW or RDF materials. For example, it is expected that mass burn MSW incinerators will operate at about the 400 parts per million (PPM) carbon monoxide (CO) guideline of the California Air Resources Board (CARB), or at 99.7 percent combustion efficiency. High efficiency multi-stage controlled air incinerators can routinely operate at 50 PPM CO levels or 99.9 percent combustion efficiency at 12 percent carbon dioxide.

2. Smaller, modular, RDF multi-stage controlled air incinerators have much lower potential air emissions. For example, the United States Environmental Protection Agency air pollution emission factors AP-42 show that a typical mass burn MSW incinerator has a total solid particulate emission factor about ten times or more greater than a controlled air incinerator. This also means less dioxin/furan and heavy metal emission potential from controlled air incinerators, compared to mass burn MSW incinerators, since such emissions are associated with total solid particulates.

3. Total potential acid gas emissions from RDF incineration can also be expected to be less than MSW mass burn incineration: less wastes will be burned in RDF systems, and some halogenated plastics will be removed in the RDF production process.

4. Multi-stage controlled air incinerators having three or four combustion stages, and exhaust gas recirculation, will have less dioxin/furan, and oxides of nitrogen (the components of smog) emissions, than mass burn MSW incineration technologies; thus lower photochemical oxidant potential air contaminants will be generated from such RDF combustion systems, as well as lower potential toxic emissions. The benefits of such lower emissions from staged combustion and exhaust gas recirculation, which are features of the latest high efficiency controlled air incinerators, are noted in the CARB Resource Recovery report.

5. A controlled air modular multi-stage RDF incinerator will require a smaller, less costly dry scrubber air pollution control system than a larger MSW mass burn incinerator. Dry scrubbers using alkaline injection and fabric filtration air cleaning systems will properly control conventional, acid gas, and toxic air emissions, such as dioxins/furans and heavy metals, from all types of waste incinerators, if properly designed and operated.

6. Recycled waste cement dust can be economically used for RDF incinerator dry scrubber-baghouse air cleaning systems; and can minimize the toxicity of incinerator flyash, which could be recycled back to cement plants for reuse in cement products. Such ash recycling should be encouraged to minimize landfill disposal problems.

NOTES

1. See Public Health Risks from Resource Recovery (Waste-to-Energy) Facilities: A Report to Residents of Edison, New Jersey, prepared by the Institute for Local Self-Reliance, February 1986.

2. A survey of 53 resource-recovery plant managers by INFORM of New York City, revealed:

   - less than half of the plants surveyed by INFORM claimed to monitor continuously for any kind of pollution. Of the 50 plants responding, 42 percent said they tested for particulates, 18 percent for carbon monoxide, 10 percent for sulfur dioxide, and only 8 percent for nitrous oxides.

   - none of the plants said they tested for all the pollution and combustion indicators -- nine in all -- that INFORM will use in its plant evaluation.

   Also, the U.S. Environmental Protection Agency air monitoring program conducted inadequate inspections about 40 percent of the time in 1984, according to the General Accounting Office. See New York Times, November 24, 1985.

3. See Konheim, Carolyn, "The Politics of Resource Recovery," Waste Age, November 1985 -- "Be sure your town council has the political courage to resist the call for a referendum on the project. Do not become preoccupied with the community or neighborhood immediately adjacent to the site, since it is extremely rare that such residents are supportive before a plant is built."

4. See Evaluation of the Proposed City of New Haven Resource Recovery Facility, report to the City of New Haven (Connecticut) Board of Aldermen, prepared by the Institute for Local Self-Reliance, November 1985.

5. See "Solid-Waste Disposal: No Pat Answers at Hand", New York Times, September 29, 1985.

SOURCE SEPARATED RECYCLING

Paul Gallimore
Long Branch Environmental Education Center
Leicester, North Carolina

I think that today we're really getting a glimpse of what it means to say "there is no away." I'd also like to acknowledge some of the native people here, the Tumuquans and the Apalachians and as I understand it these cultures were mound builders similar to the native peoples in the Crystal River area. For these peoples, waste was not regarded as something to throw away. Their away was part of their culture, it was an integrated part. So much so that they used the very refuse, the shells and what not, as mounds for their cerimonial purposes. Perhaps if we're really interested in developing a sustainable culture which I think everyone here is by the mere fact of your being here, that perhaps we can see a way of integrating our waste as resources. We can begin to build them into our culture in some sort of a positive way, where we really do begin to work with them as resources and not try to separate ourselves from them in some sort of a dualistic way.

I'm not actually a doctor, but other people here have been referred to as doctors and I think perhaps that's an indication that there's a healing that is needing to take place now all across the country. Anybody who has some ideas or potential solutions that can be applied in that kind of a healing way can take part in that doctoring. That's what we're really talking about is healing our relationship with ourselves and with the earth.

There's three real good reasons for source separated recycling: resource conservation, having respect and appreciation for where these resources come from; conservation of energy, all the way through the system; and avoiding pollution. Pollution prevention is not only makes good environmental sense, it makes good economic sense.

We got started with the North Carolina recycling/waste utilization project about a year and a half ago. North Carolina is having many problems in the waste area. Landfills are becoming contaminated with hazardous and toxic materials, not unlike the situation here in Florida. Although, our groundwater is a little bit deeper. There is the threat of the burn industry coming in to take these resources. A number of us have been concerned that the trade-offs that might be involved in incineration of these resources may be too problematic to just go for whole hog.

We like to see them more as individual components, not as a mass. Mixed garbage is a mess. As anybody who has fooled around with a waste composition study, if you muck around with Pampers in a landfill you'll know what I'm talking about. It's difficult to extract the value of that.

Our project was developed because we realized that in Ashville we had less than four and one-half years left on our landfill. As an engineer told us earlier this week, when you have less than five years left at your landfill, you automatically have a crisis. Now, I'm not sure what the landfill life expectancy here is in Alachua County, but I'm sure that any attempts that you make at reducing the amount of waste that goes in will be able to extend the life of that landfill.

We got together with citizens, environmentalists, and educators to say, "What can we do? How can we have a major impact on the public policy in this county? Where will our resources go? Will they go away? No. How can we get some utility out of it? Do we just say it's garbage and try to separate ourselves from it or do we actually try to work with it in some sort of environmentally responsible way?" What we decided upon was a list of people in the community who had experience in civic affairs, people who had worked on the landfill advisory board, a retired chemist who worked with the hazardous waste advisory committee with the county, people who were involved with litter control, good citizens all and we said, "Look. Let's make a list. We'll give it to the county commissioners to see about putting together a task force that will begin to examine some of the alternatives on solid waste and what we call 'integrated' resource recovery." We're not willing to give up the words "resource recovery" to the burn industry because we feel that we do have resources and we can make good use of them.

So, we came up with the list and gave it to the county commissioners. They realized they had a crisis on their hands with the limited landfill life and so they said, "Okay, let's go for it. Let's put together the task force. Let's lay out some of the alternatives and the begin to do our planning."

The first step of the task force was to put on a conference. The title of our conference was "Waste to Resources," which we held March a year ago. We had tremendous participation on the part of the city and the county, the planning office and over 80 individuals from the county. It was just a small affair at the University of North Carolina at Ashville, but it really resonated with people's understanding of the nature of the problem. The people could see that indeed we had to do something. We could either make a mess or continue making a mess or we could try to work towards an orderly disposal. Disposal is not away, disposal is an orderly placement. I think that that was what many people had a sense of and that's where we wanted to go.

At that conference, what we did was "consensus planning." In other words, we came up with a list of possibilities, such things as drop off centers, which generally are comprised of aluminum, ferrous metals, glass, paper, corregated cardboard. People just drop off as a way of keeping out of the landfill. We discussed the possibility of a buy back center where people are paid. There's an economic incentive for bringing these materials in. We also discussed curb side recycling. I think the curb side recycling program is perhaps an example of a more mature recycling effort.

I understand that here in Gainesville you're about to embark on a pilot project of curb side pickup in a certain neighborhood and I think that's really admirable. I think, though, that in combination with that, you need to focus quite a bit on the public education that's involved in that program to make it effective. You need to get a 90 percent participation rate in that curb side program in order to be able to expand it into other neighborhoods. You also need to work with the existing recycling that's going on here. Gator Recycling, I believe, takes aluminum, ferrous metal, glass, paper and corregated. Although it may be in its infancy here in Gainesville, you already have an infrastructure to work with and that's important. You don't have to start from scratch. You can begin to put more juice into what's already here. That's another way of energy conservation.

At this conference, we really did have a consensus emerge after we discussed all the options. I should say that no one spoke that highly of incineration. We didn't have any proponents of mass-burn and I think it was because it was focused on trying to deal at the community level without massive inputs of capital. Resource recovery is extremely capital intensive. I work in the energy field also and what we've found is sort of an analagous situation with nuclear power. Nuclear power is very capital intensive. It pulls money out of the economy that could be going into efficiency improvements. Caulking, weatherstripping, double paned glass. These kinds of things that can ream tremendous amounts of energy out of what we already have without the massive kinds of capital inputs that are required by large centralized energy systems.

Mass-burn is a similar case. It requires vast amounts of money to destroy the resources. There's some energy to be gained through steam production and electric generation, but again we have to look at the capital cost. $150,000 per installed ton of capacity is not an exaggerated figure, according to "Waste Age" magazine. Dan Knapp could do a lot with $150,000 a ton to set up a recycling program, as well as the recyclers in New Jersey. So, we have to look at what's going into the system. What kinds of capital costs are we going to incur? How fiscally responsible is it to make this kind of an investment to destroy something? Could we not use some of our resources to begin to recoup some value from some of these resources?

One of the things that we identified at this conference and in the ensuing six-month period that this task force met was the need for an accurate composition study of our waste stream. Now, I understand that a composition study has been done here in Gainesville, perhaps as recently as 1979. I would suggest that you need to update this composition study to get an accurate reading.

How much glass? How much paper? How much organic matter? We had some earlier composition studies done and found that between 20-30 percent of our waste stream was in yard waste. Materials that could be chipped and composted. So, one of our first recommendations to the commissioners was as a way of adverting the strain on the landfill to purchase a grinder, which could chip the wastes, make them into a mulch and this could be sold for $12-$15 per ton. Mecklenberg County has a grinder and they can't keep the wood chips on the lot. The wood chips sell almost faster than they can make them. The demand for this mulch exceeds their supply. Winston-Salem has a grinder and their operation is city owned and operated. They have a separate brush collection component to their operation. They're able to divert all this material and sell it as a boiler fuel for approximately $7.50 per ton which is a very low dollar value for that material. In Mecklenberg, they sell it for $12 - $15 per ton. So it does have many uses and we're getting some value out of something that previously we tried to discard and get rid of.

The second aspect that we identified in the waste stream that was of use to us was the tremendous volume of reusable, repairable items. Screen doors, solid core doors, windows, tongue and groove flooring. A whole host of appliances and furniture and toys that with very little effort can be repainted or repaired and resold at a flea market or you can donate it to needy people. It's difficult to get a handle on the exact composition of those kinds of materials either in cubic yardage or in tonnage.

We needed an up-to-date composition study, so the county has allocated a $5,000 grant for this purpose and we have received a matching grant from the Pollution Prevention Pays program run by the State of North Carolina's Department of Natural Resources' Community Development to pursue this. We've been able to expand this composition study to a three county area in the mountains. From this we're going to be able to get some very reliable data on what we have. I think one of the important things to put into a composition study that is oftentimes overlooked is the category of reusable, repairable items, an element which can be recovered with very little processing.

So, for the course of the year working with the county commissioners, we have been able to bring them around. They have been leaning towards an incineration facility in the county. They are looking at what they call a "co-incinerator." It's actually burning the sludge from the metropolitan sewage district along with the solid waste. Sewage sludge does not have a great deal of btu value, especially in the high moisture contents that are involved. So, it's likely that you would be getting a lot more particulate matter and other things generated from the combustion of that. We've been able to work with them and say, "Look, we have a sludge material here that when mixed with woodchips which we can produce from our yard brush can make a compost which can be used as a soil amendment." This is a much more benign way of solving some of our waste problems than trying to incinerate it and then figuring out what to do with our hazardous and toxic ash. The state of the art liners for landfills fail. So there's a question of what to do with this kind of hazardous and toxic residue from the ash.

This process has been one of public education because typically people in our culture don't align themselves with garbage. In fact that's what we try to avoid. What we're finding is that the more we discuss the component elements of the waste stream, the more people can relate to it. That's what we mean by source separated recycling.

We have identified several financial areas that can work towards promoting the source separation of materials. We have, with the Institute for Local Self-Reliance, put together a publication called "Financing Mechanisms to Promote Recyling at the State and Local Level." It's case studies from all over the country of various programs that have worked. Of course, Mary Shiel's New Jersey program ranks very highly in there. I'd just like to go through a list of them very quickly to give you an idea of some of the programs that are happening.

Massachusetts has a $10 million bonding program to finance regional recycling facilities. This is analagous, I think, to the Florida resource recovery equipment tax exemption. Why can't the recycling industry tap this money? Why does it have to go to incineration? This is a question that you're going to have to work on here in your state. Other state appropriations for solid waste are to be found in Alaska, California, and Michigan. Michigan has a $10 million Clean Michigan fund, which can be used for recycling. Minnesota has bonds to the tune of $15 million. New Hampshire, New York, North Carolina with the Pollution Prevention Pays program, Pennsylvania, and Wisconsin all have state appropriations for recycling.

Litter taxes are in Nebraska, New Hampshire, Ohio, Rhode Island, Virginia and Washington. The idea being that you can place a tax on fast food outfits as a way of preventing or to pay for the collection of litter. This money can be channeled into other forms of recycling.

Solid waste fees are found in Fresno, Palo Alto, San Jose and San Francisco, California; Mecklenberg County, North Carolina; and Lane County, Oregon. Mecklenberg County has a program whereby if you bring in a bag full of recyclables, either ferrous metals, aluminum, paper, that they will waive the tipping fee for your garbage. So this is an incentive to recycle. I think that they figured that something over 80 percent of the people who were coming to the landfill made an effort to bring in a bag full of aluminum cans or glass or paper. So, it really does work. The people can respond. We have a tremendous ability to learn. I think that's our real saving grace that we're not condemned to drown in our landfills or to breathe toxic air. We can find creative alternatives and make them work.

Landfill surcharges. I understand that you have about a $15 per ton tipping fee here in Alachua County and that's about twice what we have. It's good to know that because in many cases in North Carolina, counties don't even have tipping fees. So, there's absolutely zero economic incentive to recycle. This is something that we need to get across to people. We need to start taking full economic responsibility for our wastes. We just can't assure that the municipality or the county is going to take them for nothing and deal with them in a responsible way because as we've found they don't. Our water quality suffers and our air suffers as a result of that.

One of the things that we've seen working around the country and that we're trying to build into our county is that as we need to raise our tipping fees to begin to pay the full cost of dealing with our waste, we also need to allocate a certain portion of that towards encouraging recycling. This is done in San Francisco, California; Boulder, Colorado; Illinois, Michigan, Minnesota, New Jersey, New York and Ohio. I think, again, this is something that would be appropriate for you to look at here in Alachua County and in the other counties in Florida as a way of generating some revenues to begin to encourage recycling. In other words, we can say, "Oh, yes, we want to recycle. We don't want to burn and we don't want to pollute our groundwater with landfills." We need to create some momentum. One of the ways of creating this momentum is generating some finances for it.

Tax credits and exemptions for equipment dealing with recycling are found in Arkansas, California, and in Florida with the resource recovery equipment tax exemption. Please look at this as a possibility for capitalizing some of the recycling equipment that's needed. Indiana, North Carolina, and Oregon also have tax credits and exemptions for the purchase of equipment for recycling.

Vermont has recently come up with what I regard as a model piece of legislation on recycling. It's called the Vermont Recycling Act. I think people in Florida who would like to work on the policy aspects of generating a recycling plant should study this.

One of the other things that we talked about was what sort of ways do we actually encourage waste. What we found was by not having a variable fee for the collection of waste, we're encouraging generation of that waste. In other words, if you generate one can of garbage you pay the same amount per month as if you generate one dozen. There needs to be a sliding scale. We need to build that into the fee structure that the franchise haulers are charging for the collection of this waste. If you generate less garbage, you should be rewarded in lower fees. So, this is something to begin to incorporate here.

The task force in our county came up with a report which pretty much walks through the process. We identified the need for the composition study and we identified the areas where we could quickly remove as much as 40-50 percent of the waste stream through yard waste and paper. The media has been one our biggest allies, as I think they are potentially here in Gainesville. The articles that I've seen leading up to this conference have been very positive. The media has taken a real interest in this and will be your biggest ally. This is how we communicate with each other. This is how we get some of these creative ideas out into the open. The media certainly has worked with us well. The editorial on Thursday, just before Dan Knapp's presentation to our county commissioners was "Trash Reduction: We Must Act Now." This is what we've been pushing for over a year and they're really starting to learn.

I'd just like to finish by saying that I'm reminded of the phrase, "we don't inherit the earth from our parents, we are borrowing it from our children."

SOURCE SEPARATION DRIVES
A COMPREHENSIVE RECYCLING SYSTEM
IN BERKELEY, CALIFORNIA

Dr. Daniel L. Knapp
Urban Ore, Inc.
Berkeley, California

This conference, aptly titled "There is No Away," has attracted an unually large number of speakers who are academically distinguished as well as qualified to speak of practical matters. My own chosen field of higher learning was Sociology, and I can tell you it is a long way from the university to the dump. But I have traveled that road and now I'm here at the University of Florida to tell that story and what has come of it so far.

Sociology and Source Separation

Actually, Sociology prepared me relatively well for a career in recycling. My general impression after years of immersion in this important new industry is that the technology to do effective recycling is already here. It's no great trick to reorganize scales, trucks, forklifts, loaders and balers into new configurations and call them recycling centers. But after all this hardware is financed and in place, what is needed is behavioral change on a very large scale. People just have to learn new habits concerning the ways they think about and dispose of discarded materials.

Sociology is a body of knowledge, concepts, and theories about people in groups: how they behave, how they change, how they can be changed. There is an inbred optimism in Sociology about people's capacity to change progressively that is hard to find in fields such as, for example, engineering. Maybe that's why engineers as a group are the champions of technologies like garbage incinerators or even garbage composting systems: they just don't believe that people have the capacity or the will to do things differently. They seem to believe people will always put different materials into the same container, after which it will become someone else's job to make this unwholesome stuff disappear, by burning it, landfilling it, or -- heaven forbid -- composting it. Many engineers don't like to talk about source separation because they believe it is idealistic nonsense.

I am here to tell you that the research and demonstration work that I have participated in over the last decade points decisively in the direction of source separation as the eventual total and complete solution to the solid waste problem. Indiscriminate mixing of incompatible materials is the first step toward wasting them, and more than a decade of "resource recovery" experiments have proven it is a step that is all but impossible to undo. The biggest barriers to effective materials recovery at this time are not technological, nor are they rooted in people's laziness and unwillingness to change. The biggest barriers are institutional and cultural, and they are defended legally and politically by some very powerful players.

But I'm getting ahead of myself. What I want to do here now, since nobody at this conference has shown any pictures of what an actual working materials recycling system looks like when it is based on source separation, is to supply some images taken from Lane County, Oregon, and Berkeley, California. This will be an evolutionary sort of presentation, because the system I have helped create is open-ended and unfinished. It has grown incrementally by fits and starts, and sometimes it has contracted, usually due to political reverses of one sort or another. Also, it began in the most humble and primitive circumstances and gradually achieved the sophistication you will see only because the people who made it work had the grit and determination to stay with it when times seemed worse than impossible.

Recycling Wastes Into Resources

Urban Ore started with no funding at all from outside sources. Not that we didn't try for grants -- the company's name came from a proposal that I wrote -- but nobody was granting any money for landfill recycling. All we had was the waste stream itself, at a landfill that was then classified as an open dump, meaning that the garbage was not being covered by dirt at the end of each operating day. Starting in 1980 with scrap metals and a flea market, Urban Ore has become a business that in fiscal 1985 grossed over $600,000 and operated from three locations, including Berkeley's new refuse transfer station. There are two other recycling businesses in Berkeley as well, each of which could tell its own story of growth through adversity from extremely humble beginnings. They handle the traditional recyclables -- cans, bottles, cardboard, and paper -- and their gross income is over $1 million per year. So recycling has become a relatively large enterprise in Berkeley.

My personal recycling story begins before Berkeley, though. I'll start with Lane County's garbage transfer station in Eugene, Oregon. Like most garbage transfer stations, the one there is a pit. Pit designs make recovering anything useful next to impossible once it has been dumped, because the hole people dump into is 15 to 20 feet deep. To make matters worse, there are usually vertical concrete walls. Even if you had a ladder, you could not go down there to get anything out, no matter how valuable it might be. There are huge machines that run back and forth constantly smashing everything, mixing every object with every other object, then pushing it to discharge chutes at the end of the building. Big trucks whose trailers can carry 100 to 120 cubic yards of this messy stuff at a time are driven under these chutes for loading. Then they transfer the garbage to a "sanitary landfill" located out in the country. Lane County is lucky to have its landfill only 13 miles away; other communities such as San Francisco must now haul garbage over 60 miles to these rural dumps.

Recycling enthusiasts at this facility faced another problem: garbage production happened first, and materials recovery was at the end of the line. Customers with separated loads of recyclables had to drive all the way around the garbage tipping area to get to the recycling facilities the county provided. Therefore, the easiest, quickest, and most convenient way to get rid of discarded materials was just to drive to the edge of the pit on the near side and drop them over. While I was studying this facility as a county employee and as a user of the system, I saw many useful and valuable resources destroyed. It all seemed avoidable, but a systemic redesign was necessary to increase materials recovery.

While I worked for the county I helped design and administer a demonstration project that became the prototype for what happened later on a much larger scale in Berkeley. It was called the Metals Recovery Demonstration Project. It doubled the recovery rate and more than tripled the income for metals scrap by making some simple, low-cost additions to the existing system. The core of the program was a new job staffed by a person who received the materials, sorted them initially into broad categories, then performed certain elementary separations using hand tools. The purpose of these operations was to create clean flows of copper, aluminum, lead, brass, iron and steel from the metals part of the recycling area. These six metals were further sorted into over twenty subcategories according to specifications commonly employed by the scrap metal buyers. Each separation brought in more money. Prior to this innovation, all metals had been simply jumbled together in the same bin and sold as mixed metals for a very low price.

As we created this new recycling option we were aware that we were working in the shadow of a mechanized "resource recovery" plant built at a cost of many millions of dollars that was billed as a high-technology version of what we were doing. But it was capable of only the grossest separations, creating a ferrous fraction, a burnable fuel fraction, and an unrecycable fraction that would be landfilled. Our staff publicly doubted that it would work, and predicted its eventual demise -- quite accurately, as it turned out. The plant's products turned out to be just modified forms of garbage, one with a high iron content, the other with a high percentage of burnables. Neither was clean enough to be sold, or even used for the intended purpose. So both were landfilled. The garbage separation equipment was very unreliable, and eventually the plant self-destructed in 1980 after two years of heroic attempts to make it work. A massive explosion tore the roof and sides off the building in the middle of a working day and put an end to Lane County's experiment with recycling garbage.

Down in the Dumps in Berkeley

By then I had moved to Berkeley, California, and was working full-time in a recycling business based at the city's landfill. Much of what I had learned while supervising the metals recovery demonstration project was immediately useful, but conditions were unbelievably primitive. To make a place to work, I had to clear a massive pile of tires. The tires were inhabited by rats. The ocean breezes blew bushels of paper and plastic fragments into the work area each afternoon. Disposal customers drove their trucks and trailers up to the edge of a hole that was scooped out of the landfill by an antiquated crawler tractor several times a day. To recover anything, the salvage crew had either to convince people to drop it off for recycling, or more typically, we had to go over the edge down into the pit and haul things out by main force. The system was very inefficient. Getting large or heavy items out was nearly impossible. Small items could pose impossible dilemmas if there were many of them. We worked against time and gravity, because while we worked more materials would come cascading down from above. Although we saw materials every day that had great inherent value, we had to concentrate on what could be sold immediately for cash. Nonferrous scrap metals were one such category; reusable goods were another. Everything else just slid on by, and was buried.

Within a few months we were able to convince landfill management to fill in the pit and devise new procedures for tipping onto flat ground. One reason they agreed to this was to reduce liability exposure: people's cars, trucks, and trailers kept falling in. The pit was filled with garbage, the permanent paved tipping platform abandoned. Now we had a much easier time getting materials, although the footing was treacherous. The compactor crew would create a broad, flat area about 400 feet wide and 100 deep to serve as a tipping area. Trucks would be directed to the rear at first, tail in, side by side, and close. As loads were dumped, the tipping line would proceed forward until the entire area was covered with trash. Then a big jointed compactor with enormous toothed steel wheels would push everything to one side, and the tipping cycle would begin anew. Such tipping areas could be used only for a few months; new levels were then established in other sections of the landfill. New temporary roads would be built into and out of the area. Our salvage crew followed the tipping area. Sales and processing moved much less frequently.

When I salvaged actively from the tipping area, I always carried a canvas bag slung over my shoulder with some screwdrivers, a pair of cutters, an adjustable wrench or some vise-grips. With these I could dismantle many things and do a lot of cleaning right out there where the materials were. This saved a lot of time and energy, and increased productivity and income.

Since the salvaging and sales areas were separate, our crews used trucks to collect and transport the salvaged items. Used Step Vans from a local bread bakery were the most useful. They are roomy inside with a low floor of diamond-plate steel and a ceiling high enough that even a tall person can walk inside without stooping. Bread trucks function well as big, motorized bins. Smaller conventional vans and pickup trucks have also proven useful. Collected materials are unloaded at appropriate points in the sales area. Then they are classified, cleaned, and generally prepared for storage or display.

As in Lane County, we used hand tools for most of our cleaning and dismantling operations. To get the highest price for scrap aluminum, for example, certain typical contaminants such as steel sheet metal screws and rubber and plastic weatherseals must be removed. Copper occurs in plumbing and electrical applications, where the contaminants are likely to be iron, steel, or plastics. A good source of lead is old cast iron sewer pipe; breaking the brittle iron to release the lead greatly increases the price paid for the weight recovered. Hammers, chisels, crowbars, screwdrivers, pliers and visegrips were the basic tools used for this kind of "mining." One of the most versatile and useful tools are the long-handled cutters; Urban Ore designed its logo using this tool as a basic design element. The inspiration for the design came from a book of medieval Japanese family crests!

By these operations performed with simple tools, our salvage crews were able to raise the value of scrap metals from less than a cent a pound, unclean and mixed, to highs of $.25 to $.35 per pound. Not everything was that valuable, of course, but the process, which we called highgrading, was the basis for virtually all of our later expansion.

The other fundamental was selling for reuse rather than scrap whenever possible. Take a gas-powered lawn mower, for example. You can throw it into the mixed metal bin, and it will bring about $20 per ton, or less than a dollar. But if you have a reuse sales area it will definitely pay to see if the motor turns over by pulling on the starter cord. If it does, it should be worth a minimum of $5, and it may be worth up to $25. This principle works across a broad range of materials. I recently experimented with selling live plants taken directly from the tipping area at the compost facility. These were plants with bulbs and tubers, like irises, freesias, and gladiolus; or hardy plants with water-holding leaves like cacti and succulents. All sold for good prices within a few days after being taken to the salvage sales area. Alternatively, they could have been "scrapped" by running them through the tub grinder and turning them into compost. But the monetary return would have been lower. Urban Ore was built upon a foundation of intelligent discriminations such as these.

Prices are a product of experience, negotiation, and a lot of plain guesswork. They are hardly ever printed on anything, so it isn't like a standard retail business. Customers who are recent immigrants to this country usually have a big advantage over a newly hired salesperson for our company whose only prior experience is shopping downtown or at the supermarket. People from other countries are used to negotiable prices, and really know how to bargain. Often they start out by insulting the merchandise, the business, or the salesperson. You have to learn to let this kind of treatment just roll off, refusing to be intimidated, or the good things will go for ridiculous prices and you'll end up with the junk.

Most people are courteous and reasonable though, and rough price ranges become known and acknowledged for each category. I like to call our markets "handshake markets," because unlike the regular recycling trade, wherein materials are sold to buyers thousands of miles away, in the recycling of reusables your buyer is right there with you and the two of you set the price.

Separating Building Materials from the Flea Market

Virtually anything created by human beings can ultimately show up at a landfill, and for the first year our developing "flea market" fully reflected the complexity of our material culture. But gradually we discovered that building materials did not sell well there. Doors, windows, sinks, toilets, bathtubs, lumber and lighting are all delivered regularly to landfills by independent contractors who remodel and renovate existing structures. In most urbanized areas, remodelling and renovation are larger sources of revenue than new construction. Nearly all remodel is preceded by a tearout phase, which is where these materials are generated. This large category of reusable goods was split off from the landfill and relocated to a commercial part of the city because we found that we could not sell these materials effectively at the dump. Once this was done, we reoriented our supply market to our specifications by purchasing materials delivered in a clean, reusable condition. In metaphorical terms, the building materials facility moved up the waste stream closer to its source. Materials that formerly went to the landfill could be disposed of in a better way.

This facility moved three times in six years, but each move was an opportunity to reorganize and sharpen the focus of each department. As in highgrading, there is a direct correlation between the number of subcategories for each major materials grouping and the income that can be achieved. The simple category "doors," for example, subdivides into more than a dozen subcategories with names like single- and multi-light doors; entry doors; panel doors; solid and hollowcore doors; and more. Windows show similar complexity. Arranging these materials neatly into natural categories by size ensures successful marketing.

Today the building materials recycling facility occupies about an acre of commercial property, and the annual gross income is more than $200,000. It buys about 80% of the goods it sells; the other 20% comes through donation or dropoff. Surplus revenue generated from this operation and the flea market were the main source of financing for Urban Ore's compost venture, about which more later.

The Evolution of Recycling at the Solid Waste Transfer Station

Our flea market went through a major transformation when the city closed its landfill in 1982. Urban Ore was a latebloomer in Berkeley's recycling picture, and there was no place for us in the city's 1976 solid waste plan that called for a refuse transfer station with limited front-end recycling. The city had opted to build a garbage burner instead of committing funds to materials recovery. But substantial opposition developed to the garbage burner, and in the 1982 elections an initiative passed with more than 60% of the popular vote behind it that placed a five-year moratorium on burn-plant construction to "give recycling a chance." All of Berkeley's recycling companies benefited from the pause in the city's headlong rush to incinerate solid waste.

Between 1982 and the present, Berkeley's refuse transfer station has been drastically altered to a refuse and recycling transfer station. Space devoted to the two functions is almost equal. Recycling is first in line in the linear flow of traffic up Second Street north of Gilman and parallel to the shoreline freeway. This gives people who want to recycle a chance to do so conveniently; their minimum reward is a reduction in volume or weight for their discards, which translates into a lower disposal fee. In many cases, they may also earn some money for their troubles. At the other end of the line, where the garbage is dumped, both the city and Urban Ore employ salvagers to recover recyclables. This ongoing salvage effort is a lineal descendant of our operations at the now-closed landfill.

First in the recycling lineup is a modern buyback facility for recovering container metals and glass, paper, and cardboard. People disposing of these materials queue up in their vehicles and wait for their turn at the scales. Then they unload the separated materials onto the appropriate scaling equipment, and weights are recorded and fed into a computer. When each transaction is finished, a check is printed automatically at the office and given to the customer, who exits onto Gilman Street. For those not wishing to use these streamlined procedures in return for pay, there is a dropoff facility on the same lot for the same materials. The dropoff area also takes used oil and larger scrap metal items.

The receiving area is separate from the processing area. Materials transfer is accomplished by several forklifts with rotating heads, allowing for the quick dumping of bins. The mechanical heart of materials processing is a large baler capable of producing export bales of paper, cardboard, steel and aluminum cans, and light aluminum scrap. Glass is sold color-sorted. Encore!, another innovative recycling business born in Berkeley, has developed a strong market for reusable wine bottles. The scale for container metals incorporates a magnet to sort ferrous from nonferrous cans. This same processing plant is also the unloading terminal for the monthly curbside collection run by Berkeley's Ecology Center, one of the oldest recycling firms in the nation.

Next in line on the site is Urban Ore's flea market and salvage area. This facility is a dropoff and buyback area for reusable goods of all description. People can drive through and unload on their way to the refuse tipping area. Reusable materials rescued from the tipping floor are also brought here for sale. There are some building materials, but mostly there are household goods, furniture, appliances, antiques, and a broad range of collectibles. The flea market is Urban Ore's most profitable venture, and has functioned as the major source of financing for the compost facility over the years.

Refuse Transfer Replaces Nearby Landfill; Disposal Costs Rise Precipitously

The last stop in this part of Berkeley's recycling system is the refuse transfer station. This is the successor to the nearby landfill, which closed for good in August of 1983. Unlike most refuse transfer stations, Berkeley's does not employ a pit where everything is dumped off a high wall. Instead it has a specially hardened floor where tipping occurs. It is not as large or expandable as the landfill was, so the incoming material has to be pushed and compacted more often, but the floor design does permit more salvaging than a pit would. The city has recently been considering a substantial redesign of this facility, in part to increase recycling levels. This is necessary because the refuse transfer station really was not designed with materials recycling in mind; rather, it was to be the staging area for the refuse incinerator, which was never built. If recyclers had been more involved in the design of this facility, ample storage for recyclables and separate unloading areas for different load categories would have been constructed. But even without these improvements, thousands of tons of recyclables are harvested off the floor each year. The city usually has three or four workers who direct unloading and who also salvage cardboard, scrap metals, and glass from the floor. And Urban Ore stations one and sometimes two workers to pick up reusable items that get past the salvage facilities farther up the line.

All of the salvage workers are expected to wear protective clothing -- dayglow vests, hardhats, hardsole boots, gloves, and dust masks when conditions warrant. City workers remove salvaged materials to bins that are spotted outside the building and along one wall. Urban Ore workers use a pickup truck with a lumber rack, or the old reliable bread truck.

The materials that escape all these recycling options and systems are sent to landfill as mixed garbage. The garbage is pushed and piled in the center of the transfer station floor. As long-haul trucks are available, a rubber-tired loader shoves the garbage over the edge of a hole in the floor. Underneath is a waiting tractor-trailer rig, which holds 120 cubic yards. When it is full, it pulls up its access ramp to street level, turns onto the freeway, and starts the long uphill trip to the landfill.

For the first couple of years after its landfill closed, Berkeley's garbage only went 13 miles to landfill. But nearby cities, mindful of the limited time before this facility would also be forced to closed, complained so loudly and effectively that Berkeley was forced to redirect its wastes to a landfill 45 miles away. Since 1982, tipping fees for mixed materials have risen from $4 per cubic yard to more than $8. This drastic increase is one of the main reasons so much time and attention have been given to recycling.

The Compost Facility Recycles Plant Discards into Mulch and Topsoil

The largest single part of Berkeley's comprehensive recycling system is its compost facility, which Urban Ore pioneered. It opened in September, 1982, one year before the landfill closed. At the time, it was about an eighth of a mile in front of the landfill fee gate. The first day, the compost facility took about a quarter of the traffic away from the landfill. This proportion of recovery continued until the new transfer station opened about a mile away and closer to the major highways. There was a slight decrease in volume at this time. Another decrease occurred when we raised the tipping fee from $2 per yard to $4 per yard in 1985. Many customers protested, and some began hauling their brush directly to the Richmond landfill thirteen miles away, because it was much cheaper. In 1986 we raised the fee again to $6 per yard. This time patronage decreased very little and there were fewer protests. It seemed that we had found the bedrock of our supporters. They liked being part of a natural process of recycling, besides appreciating the fact that, even at $6 per yard, the compost facility was still cheaper than the nearby refuse transfer station.

The intake procedure for composting is similar to that used by landfill and transfer station operators in our area. The disposal customers stop at a feegate; the load is inspected; the volume is estimated or measured if necessary; and a fee is assessed and collected. Then the customer moves on to the tipping area and the load is dumped out on the ground. Grossly contaminated loads containing trash, rock, or metal are rejected at the feegate, and the customer is directed to landfill or to the city's transfer station. Tipping is monitored by site workers, and if there is any contamination it is removed to a dumpster. Several times each day, the accumulated material is pushed, compacted, and stacked by a wheeled loader equipped with a grapple.

Merely compacting green brush by piling it up is enough to start vigorous composting action immediately. Shredding is not necessary for composting, although it speeds up the process. Whenever we broke into a stacked pile of brush with the loader, great billowing clouds of steam would puff out, a sure indicator of rapid decomposition. Large brushpiles produce finely decomposed humus from the fallen leaves and twigs within a few months, given enough water, while the large branches on top of the pile may take two years. This is as Mother Nature intended. But having a shredder allows the process to be accelerated, and the size reduction means using less space for storage.

We used a W.H.O. tub hammermill for size reduction. Another word for this type of mill is hammer hog. Mechanical hogs employing knives or blunt hammers were invented in the late 1800s. Knife hogs work well on logs and green wood; hammer hogs work well on dry wood. Green brush is neither, and our compost crew quickly found that the machine required a lot of maintenance to work reliably. The hammers -- of which there are 48, each weighing in at nine pounds -- wear down very quickly when processing brush. The origninal factory hammers lasted only about 45 hours, and the entire hammer assembly had to be taken apart so the hammers could be reversed at 25 hours. The grinder also had many belts of various sizes, and these wore out rapidly as well. Our crew developed a love/hate relationship with our machine, but gradually came to understand it and keep it tuned for optimal performance.

We were fortunate to have as a consultant Mr. Ralph Van Deventer, a retired metallurgical engineer who had also run several foundries in the course of a long and exceptionally productive career. He did some research on the metallurgy of our hammers and quickly came up with a casting concept that a local foundry used to produce new hammers for us that cost less than the ones from the factory and delivered twice the wear. Our site manager Michael Casady also discovered a source of belts that wore much longer than the ones we could order from standard sources. Another key discovery was that letting the brush dry for a few weeks made easier work for the grinder, because dry wood shatters and wet wood doesn't. Oddly enough, green leaves abrade the hammers much faster than kiln-dried hardwood. We learned from the manufacturer's representative that tub grinders used for grinding wood pallets routinely got 200 hours from a set of factory hammers, while those used in leaf-composting operations could get as little as six!

After grinding, the pulverized woody material is taken by conveyor away from the machine. Then the loader picks it up and moves it to big elongated piles called windrows. These storage windrows are then watered using soaker hoses, and turned periodically by the loader. Temperatures rise quickly to 160°, and remain high for weeks as bacteria and fungi digest the plant materials. The color changes gradually from greenish brown to golden brown to chocolate brown and finally to nearly black.

The product can be sold for different uses at any stage of the process. In the early stages, it is most useful as a mulch, laid on top of the soil to a depth of 4 to 8 inches. This gives weed and water control and slow soil improvement with little work. Older windrows show darker colors, smaller average particle size, and greatly increased proportions of fine material. Even after the compost is uniformly black, which takes 6 months to a year, there are still some sticks and larger particles. We found that the most popular form of compost was produced by putting this dark compost through a mechanical screen. The fine material that passed the screen sold very well at $18 per yard in small quantities of one to sixteen yards. In bulk, its value was around $11 in the Bay Area market. The price might be considerably higher except for the competition, heavily subsidized products like nitrolized sawdust from the forest products industry or sewage sludge compost from the local wastewater treatment plant. But Urban Ore's product was unique in the marketplace, and rapidly gained a reputation among our customers as a clean product produced from local resources.

A final point about how Urban Ore's compost operation was financed is very important to me personally. The compost facility was really a form of research and demonstration project. It always lost money, and the slack was picked up by the salvage programs that the company runs. But composting is machine-intensive, and salvage is labor-intensive. That salvage could actually finance composting demonstrates the truth of a discovery I made twenty years ago when I was writing my Master's thesis on comparative economic development. I was then very impressed with the way certain countries such as China with huge populations and little capital wealth or outside assistance were organizing their labor power to be the major engine powering economic growth. The lesson I learned was that well-organized labor-intensive production systems can be the major source of surplus value -- call it profit if you like -- which can then be used to purchase the capital equipment necessary for further economic expansion and growth. Urban Ore has demonstrated that this principle works even in a country like the United States; even in a high-technology state like California; because we used surplus value created by two businesses where the major productive factors were labor, skill, and knowledge, and built a much more capital-intensive business separate from but complementary to the others.

Reorganization, Redesign, Reintegration in 1986

After five years of very rapid growth on separate tracks, some drastic changes have overtaken and are now shaking Berkeley's comprehensive recycling system. The compost facility, temporarily located on a section of the former landfill, has been forced to close in favor of park development planned for the site. When the facility reopens, it is very likely that primary milling will be separated from compost production, with a trucking step in between to transfer the material to the production area. Having the compost receiving and grinding steps on the same site as the rest of refuse and recycling functions will once again combine all of the major handlers and haulers of discards at one point in the city. The compost production step, which uses a lot of space, can be relocated to less expensive land. It is likely that city long-haul trucks will be used to transport the material, which will be a major new development in that the city's refuse workers will begin a transition to handling recyclables.

The city will also soon relocate its entire refuse collection division from a residential neighborhood uptown to the solid waste management center. At the same time, Ecology Center's curbside program is due to expand from a once-monthly to a once-weekly collection basis. The city is also considering a major new initiative in commercial recycling using its debris-box service as a primary source of material. Recycling and refuse disposal, historically separate and even antagonistically competitive in Berkeley, are being combined physically and forced into new patterns of cooperation. The immense complexity of solid waste is normally difficult to perceive in the unsavory grey mass of garbage, but it is being unscrambled by the Berkeley system into separate and distinct resource flows.

The City's refuse workers -- mostly black and unionized -- are being brought by this physical change into close daily contact with Berkeley's recycling workers and operators, who are mostly white and nonunion. The social and intellectual ferment that is getting underway is very interesting as well as unsettling to established norms, and the outcome as expressed in concrete programs that do the daily work of disposal should be both exciting to watch and of national significance.

It is clear that Berkeley was one of the points of origin for the modern recycling movement. Experimental recycling depots were created here as early as 1967, three years before they flowered into national prominence following Earth Day, 1970. In the rude and brutal shakeouts that occurred through the next decade, only the strongest forms of recycling survived. Now recycling is being integrated physically into the much larger refuse disposal system. The pressures forcing this combination are primarily economic now, as mixed-waste disposal rapidly prices itself out of the market. Recycling even low-value commodities like plant discards has become the cheapest and most convenient way to get rid of them. When users' disposal costs are paid to recyclers as a service fee, the income from the fee added to the revenue from selling materials creates a new economic underpinning that is propelling the socially beneficial recycling industry into new prominance as the preferred option for waste disposal.

I have an Oxford Dictionary of the English Language that I found -- appropriately enough -- in the garbage. It lists "orderly placement" as one of the major meanings of the word "disposal." American dictionaries, by contrast, tend to associate the word with garbage. In fact, the word has been appropriated by the solid waste management industry and used so much around garbage and waste that this sense of orderly placement has virtually disappeared except in restricted contexts like "disposal of a relative's estate" or "disposal of a company's assets after dissolution." But as I often tell audiences where I show pictures of Berkeley's disposal system, if you were an executor of a relative's estate and you were asked to dispose of it, you wouldn't dig a big hole and bury everything, nor would you pile it all up and light it on fire. That would be irresponsible. So you would catalogue it, separate it, and find ways to give it away piece by piece, some to this relative, some to that relative, and the residue to various charities. This kind of disposal is truly orderly placement, and it is this kind of disposal that Berkeley's system has stood strong for above all.

Garbage disposal has had its day; recycling disposal is on its way.

THE ECONOMICS OF PAPER RECYCLING

George Elder
Southeast Recycling Corporation
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My subject is "What is the motor that drives the paper recycling industry?" I want to talk about commodity marketing. It's the marketing of commodity that controls the paper recycling business. Materials are bought, not sold. Prices are set for short periods of time based on supply and demand. Paper recycling in th U.S. is not a government regulated industry. We're regulated by big world economic conditions, industrial capacity, strength of the U.S. dollar versus foreign currencies and domestic mill demand.

I believe strongly that one must have an integrated approach to waste management to deal with local problems. There's room for energy recovery, composting, metal and glass recovery. Even in the paper industry, we believe in such an integrated approach to waste management. I don't recommend one specific program as a cure all in all situations. I think even in the paper industry there's an integrated approach because different kinds of people are motivated by differnet reasons, some by money and others for charitable reasons. One good way to get a program going in a community is to form a committee. The British leaders went back to England when they started having trouble with the colonies prior to the American Revolution and said, "Those Americans are strange people. When they have a probelm, they identify the problem and put together a committee. They study the problem and find the solution. So they were able to go ahead and deal with it." The British couldn't understand how we could function that way, but it works. The solution should come from within the community.

If you don't have a salesman that's involved on your committee, get one. They're beneficial to you. If you don't have an environmentalist involved, you should have one involved. You should have people in the industry involved, paper recyclers, scrap metal processors and people in the glass industry. The solid waste collectors, haulers and the private waste disposal industry should be involved. That's very important. Involve a lot of people so that you can have a partnership and you can move on to solve the problem.

There are some market factors that quite often aren't talked about in public regarding our industry. There are 10 laws I'd like to discuss briefly.

LAW #1 - There's no gold in garbage. Garbage is a liability and we all share the cost of that liability. One cannot expect to get rich quickly. One can make an investment and get a return.

That's the key to it. One cannot sell garbage. In programs we see described, they took materials that weren't sellable in the mixed form. They had to be processed, graded; you had to change the way the material looked, to make a product. You must convert that waste commodity to a product before it is sellable. You have to add value to it.

LAW #2 - One has to meet market specifications. There are six different grades of old newspaper alone. There's several grades of corregated paper. There's 100 grades of waste paper. Grades are often tailored specifically to one individual mill. Specifications regarding quality, moisture and contaminates should be clearly understood before collecting a waste material for resale.

LAW #3 - One must establish the markets first. To give you an example, lets discuss old newspaper available in the State of Florida. The total available is 608,000 tons per year. The Southeast Paper mill consumes 220,000 tons. If a state law was passed that requires recycling all newspaper in the State of Florida, we know where there's a market for one-third of it. What shall we do with the rest of it? An integrated approach dealing with multiple solutions to dynamic situations requires establishment of markets first.

LAW #4 - There must be relationships within the market. One has to have confidence in people. If one's trying to put together a shipload of corrugated going to the orient, one has to have confidence that the people preparing the material will supply enough material and will supply material that meets specification that the foreign mill requires. There are relationships that develop over a long period of time in the buying and selling of waste paper and other materials.

LAW #5 - The most important law in our industry is that these commodities are bought, not sold. Prices are controlled by the industries that buy the material, by the manufacturer locally and by the mill in Taiwan or Korea. The end user or the mill will adjust prices according to their inventory and their ability to sell finished products.

LAW #6 - A major law in the industry is to buy now, sell now. It's very dangerous to get into the business of inventorying waste paper or other material.

LAW #7 - The markets are dynamic.Economic conditions in the region and the world fluctuate constantly. When the Japanese yen is trading for 215 or 220 to the U.S. dollar, the Japanese are not going to buy our recycled paper. When it drops to 180 or 182, they're going to buy. Twenty-five percent of the waste paper market is exported, about 75 percent is consumed domestically. That 25 percent is about 3-4 million tons per year. It's a big factor. When a foreign country pulls out of the market, it is a depressing factor for our market. In Florida, you are blessed with good ports and good access to foreign markets. Export is a very important part if the strategy here. Most foreign mills are nationalized or government controlled so politics and cash reserves are major controlling factors. There are a few paper recycling mills in North Florida. Most markets are outside the state.

LAW #8 - Transactions must be profitable. Our suppliers can't stay in business if we can't pay them enough so that they can make a profit and maintain a decent They can't stay in business if they don't pay the public a reasonable price for waste. There has to be profit. So, profitability is the #1 factor that keeps a mill going. If it isn't profitable, you don't need the employees, you don't have a product and you won't be in business.

LAW #9 - The value of material is determined by these factors: the time and the place. If you have 100 tons of a material in Orlando, there is a real market. If you have 100 tons of the same material in Little Rock, Arkansas, the buyer might not be interested in it. So the place where it is is extremely important. A good portion of the paper that is recycled in this area has to be shipped to North Florida or throughout the southeast region. Freight is going to be a major cost factor and is usually reflected in the value of the material.

LAW #10 - Quality, you have to have quality raw materials to make a quality product. You can't make a silk purse out of a sow's ear. That's true. The primary problem in the paper recycling industry is contamination by glues and tapes. Treatments to paper, such as plastic coated paper, wax and styrofoam are serious contaminates. The newspaper that you brought this morning doesn't look like a newspaper that was purchased ten years ago, products keep changing. Changes in products has a direct affect on marketability.

The ability to handle the materials is an important factor. In Alachua County there is approximately 500 tons a month of ONP available. If we recycle 100 percent of that, we must handle 500 tons a month. Can the local dealers handle that capacity? The ability to handle is very important.

There are opportunities to increase recycling in the Gainesville area. I've attempted to encourage those interested in pursuing such endeavor. The two areas I discussed: The committee approach and recycling market laws will hopefully encourage you. Marketing of recyclable waste material can be very complex but when broken down into components, such as I discussed, it can be made more manageable.

PAPER RECYCLING IN FLORIDA: POLITICAL ISSUES

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I have been asked to speak on paper reycling in Florida and how political issues impact on this network. The company at which I work is a private waste paper recycler. We are what the industry would term a "packer". We collect, process, and bale various grades of paper for shipment to paper mills, which in turn use the waste paper as a feed stock for their manufacturing processes. There are many grades of paper, each of which has a specific definition and particular use for a mill.

My particular expertise is in the newspaper recycling network throughout the State of Florida. Basically, I administer a network of 26 shipment sites in Florida, one of which is Gator Recycling here in Gainesville.

I would like to set the stage with some slides to give you an idea of how newspaper is generated and collected. Unlike other grades of paper that are accumulated at places of business, newspaper is generated from dispersed sources--the household.

Once a household finishes reading a newspaper, it usually serves no further purpose and begins to accumulate as waste. I won't be able to cite the exact source, but it has been demonstrated that a majority of households actually separate their newspaper from the rest of the waste stream. It is a rigid, bulky, and heavy item and does not mix well with the normal household solid waste stream.

The fact that newspaper is often separated in the household is only the first step. The trick on the recycling industry's part is to get these households to recycle the newspaper as opposed to discarding it. There are many collection systems for newspaper, but I will describe only those that involve local governments.

One of my responsibilities in the statewide network is to approach municipalities and convince them that recycling is a cost effective and viable alternative to the disposal of waste newspaper. In basic terms, a municipality will realize savings in avoided disposal costs and generate revenue from the sale of the paper. In order for a newspaper recovery program to be cost-effective, the savings and revenue must exceed the costs of collecting the newspaper.

There are several important factors that must be considered when determining the feasiblity of a municipal newspaper recycling program. Most importantly, of course, is the city's population. The population, naturally, is going to have a major impact on the volume of waste newspaper generated in any given municipality.

Another consideration is the demographics. For example, an affluent municipality in Palm Beach County is going to generate a lot more newspaper per capita than a small rural town in Alachua County. This would be due to multiple subscriptions and the presence of larger newspapers.

In order to project the amount of newspaper in any given city, one must multiply by a per capita generation rate. This is not accurate across the board due to demographic differences, but it will approximate the total. In very general terms, each person will generate 150 pounds of newspaper per year. Once calculated and converted to tons, this figure should approximate 10 percent of the entire waste stream. In some cities it actually exceeds 10 percent, and in others it is well below 10 percent.

Another important factor to consider is the system by which the municipal waste stream is collected. From a political and economic standpoint, it is advantageous for a city to operate its own solid waste collection department as opposed to contracting with a private waste hauler. If a city operates its own collection system, it incurs a direct cost for every ton of solid waste delivered to the disposal facility. Thus, there would be a direct savings from any reduction in the waste stream due to newspaper recycling. If, however, the city contracts with a private waste hauler, the basis for payment is usually determined by the population or number of dwelling units, and not on the amount of waste discarded. With this system, the city would have no economic incentive to reduce the waste stream. Their cost would be the same no matter the volume of waste.

Once these factors have been assessed and the decision has been made to proceed, it is a matter of determining what recovery system would best fit the needs of the city. There are three basic systems that we offer a city--curbside collection, a municipal buying center, and voluntary drop-off sites.

Curbside collection involves the use of vehicles and personnel that traverse through residential areas to pick up bags and bundles of newspaper which have been separated and placed at the curb by the homeowner. Usually, specific days are designated for pick-ups. When the vehicles complete the route, they deliver the paper directly to a recycling plant.

In order to maximize participation in these programs, we encourage a city to enact two ordinances, although they are not absolutely necessary. The first ordinance would "require" that a resident recycle his newspapers. However, it should not be strictly worded or construed to mean that a resident would not be allowed to contribute his newspaper to a community organization. The curbside program should not impact negatively on other recycling operations.

The second ordinance is an anti-scavenging provision which would prohibit unauthorized collection of curbside newspapers set out for municipal collection. This would prevent private vehicles from running a route prior to the municipal crews and collecting all the paper.

Without these ordinances, participation generally will suffer. To enact such ordinances, however, requires a political risk. Often, city commissions are unwilling to pass such laws for fear of constituent concerns. As an example, a simple one sentence response from a city in South Florida sums up the problem: "The mandatory curbside collection proposal is unacceptable because of its obvious political considerations".

A curbside collection system, whether "mandatory" or not, will result in the highest participation rate and thus recover the most newspaper. Recovery rates are generally between 40-80 percent. Convenience is the most important factor with curbside collection. It is the easiest way for any given homeowner to participate.

As far as scheduling is concerned, we suggest that newspapers be collected on a separate day and not co-mingled with the solid waste stream. This will be slightly less convenient for the homeowner, but will be far less confusing for both the homeowner and collection personnel. Also, the collection should take place in the morning, if possible, to avoid afternoon rain showers.

The collection vehicles can vary. Normally, a city will designate packer trucks for the newspaper collections, but these vehicles are the most expensive to operate. Trash trucks with a hydraulic lift bed usually can handle large amounts of paper, and are far less costly to operate. A city could also use smaller vehicles or trailers, but these systems are less efficient.

There are currently six municipal newspaper curbside collection programs in the State of Florida. These are in Boca Raton, North Palm Beach, Titusville, West Palm Beach, and most recently, the town of Golden Beach. Tallahassee, I believe, also has a small pilot program.

The most successful program, by far, is in the City of Boca Raton. In the last fiscal year, Boca Raton, with a population of roughly 53,000 people, recovered 3761 tons of newspaper. If one tries to calculate the recovery rate based on the multiplier of 150 pounds per person per year, it comes out to nearly 100 percent. This is evidence of the "inaccuracy" of the multiplier. This is an affluent community in Palm Beach County. The generation rate is considerably more than 150 pounds per person per year. It has to be.

According to the City of Boca Raton records, its program resulted in an overall cost benefit of $147,000. This figure is calculated by adding avoided costs and revenue from the sale of the paper and subtracting the cost of collecting the paper. Boca Raton is a Shining example of how a newspaper curbside collection program can work.

If a city does not want to pursue a curbside program, the next option is what we term a municipal buying center. In order for this option to be feasible, however, the city must have sufficient population and lie within the direct service area of one of our three plants (i.e. Dade, Broward, Palm Beach, or Hillsborough Counties).

Basically, a buying center is a 40 cubic yard container placed on city property for the purpose of purchasing newspaper from the general public. The company hires an attendant to operate the center by weighing newspaper delivered by the public and then issuing a check. The newspaper is then loaded into the container until it is full, at which time it is exchanged for an empty container.

The only costs that a city would incur in such a program would be site preparation, maintenance, and publicity. Concerning the site itself, we need to operate on solid ground. We would prefer a concrete pad or asphalt, but packed gravel will suffice. These containers, when full, will weigh 10-11 tons and can quickly sink in soft ground.

Any up front costs in site preparation, however, are usually surpassed soon afterwards by savings in tipping fees. The city does not benefit directly from the sale of the paper, for that money is paid to the citizens, but the city does benefit from the reduced waste stream.

Generally speaking, a municipal buying center might recover 10-25 percent of the available newspaper. If a program is well publicized and has strong community support, it could exceed this figure.

Several cities now have such programs. The most successful municipal buying center is in the City of Boynton Beach. In the last fiscal year, we recovered 1218 tons of newspaper and saved the city $24,000 in tipping fees and other associated solid waste costs.

The final option available to any city is not politically sensitive. It is simply a container that we would place on city property as a voluntary drop-off site. The city would encourage its citizens to deliver newspaper to the container and oversee the site so that unacceptable material (garbage) is not mixed in to contaminate the newspaper. There is no direct financial return to the participating citizen, but the city will realize revenue from the sale of the paper and, of course, save on avoided tipping fees.

This system will intercept approximately 10 percent of the available newspaper. This low figure is due to the relative inconvenience of participation.

These municipal recovery systems vary in many ways. They vary in the degree of municipal participation, they vary in the recovery rate of newspaper, and they vary in political appeal and political reality. There is no question that a curbside collection program is the most effective system when tipping fees are high. As the state continues to confront critical solid waste disposal problems and tipping fees escalate, political obstacles will be overcome and curbside newspaper recovery programs will prove to be a financially sound and logical alternative to disposal.

BOTTLE BILL DEPOSIT LEGISLATION

The Honorable Jeanne Malchon
State Senator
District 18

I was going to explain to you a little bit about what container deposit legislation is, for those of you who are not familiar with it, and how the system works. However, in the press of time I will not take the time to do that. If any of you are interested, you can either contact me at my St. Petersburg office or contact Citizens Against Throwaways (CATS). We can give you plently of information on that or I can stay a few minutes afterwards and answer questions.

Just let me say before I do begin that I have a long history with the League of Women Voters. I spent some 20 years heavily involved with the League of Women Voters. I was a local president, a state president, and served on the national board. I have just finished a term as national president of the American Lung Assoication. I served for nearly six years on the Pinellas County Commission and, of course, I am completing my first term in the Senate. This will be my fourth session. I give you this background merely to point out that I have not been in those places or accomplished those offices without learning to do my homework and making sure of the facts before I proceed upon anything. So, that as I go quickly through things today, if you have any questions, we have the documentation to back it up. Secondly, the fact that I drove 160 miles from St. Petersburg to be here to speak with you for 15 minutes shows how important I think container deposit legislation is. Given that, let me quickly go on.

The thing you must know about container deposit legislation is that economically it is a closed system. It generates revenues within itself that pays for the cost of the system. The only people who pay for it are those who do not redeem their deposits by returning their containers. The unredeemed deposits, the float on those deposits, and the sale of the scrap are what pays for the system.

What is being proposed right now in the State of Florida by the Container Deposit, Recycling and Litter Control Committee, which is currently meeting and will have it final meeting on Monday afternoon to decide upon its recommendation to the legislature, is an alternative to container deposit legislation known as a litter tax. A litter tax differs from container deposit legislation in two ways.

1. It is not a financially closed system nor is it financially adequate. It is a broard based tax on many items which contribute to the litter and the solid waste stream. It is expected, the way it's written for Florida, to generate some $16 million in revenue . That $16 million will be paid by all taxpayers. It is a tax.

2. That revenue is not nearly sufficient to meet the costs of cleaning up litter and administering the program. It does nothing to reduce the solid waste stream because it cleans up after the fact. All of that litter that must be picked up still must be transported and disposed of as solid waste.

In container deposit legislation, the idea is to reduce not only the litter stream, but also the 6-8 percent of solid waste that beverage containers constitute.

Having been environmentally concerned for many years, I noticed that the previous speaker talked about newspaper being consumed at a certain point. Although we are called a nation of consumers, we are, in fact, not consumers but converters. We take our natural resources and convert them into solid, liquid, and gaseous waste. If we consumed them, we'd only have one-half the problem - the consumption of natural resources. We wouldn't have the waste problem.

Now, as an alternative, litter tax is not going to do the job for us - certainly not as far as solid waste is concerned. The same volume of solid waste will still be there, weight, volume, whatever you want to measure it by. It will still need to be collected, transported and disposed of.

Nine states have passed container deposit legislation. None of them has been repealed despite federal efforts. In the State of Maine there was a referendum about a year after the bill had been in effect to repeal the bill. The referendum was defeated by 84 percent which was both the highest percentage that any election had ever carried and also had the highest voter turnout. Of the 12 states that have passed litter tax laws, six of them have repealed them because they just don't work, are a nuisance and so on.

What is being proposed and what I hoped to see, although I must tell you it is very doubtful if it will come out of the committee meeting Monday afternoon, is a proposal that is a combination. It has been drafted and we just received it in the mail this week. These are some recommendations to change the container deposit legislation in such a manner as to deal with some of the problems of which the previous speaker just spoke. It would take the container deposit legislation and add to it requirements for local governments to require separation at the curb and other things in the way of encouraging recycling and separating the waste which is recyclable.

There are a few other incentives in it. The problem with the bill is that the staff combined the League of Women Voters' suggestions from our last meeting, and the League is to be commended for coming up with them, but provided no way to fund these in the bill. Your previous speaker mentioned cost to cities and so on. You also have to remember that many cities have invested in the kind of equipment where trucks go around and mechanically pick up the containers to dump their contents. That is going to have to be changed or some arrangements are going to have to be made which will cost. There will be an economic cost.

Many areas are going to resource recovery plants such as Pinellas and Dade Counties. I believe Broward has built, or is in the process of building, and Hillsborough and Orange Counties are considering them. Most of these are done on bond issues, so that if you reduce the volume of waste, particularly where electricity is generated, that reduction could mean that the revenue from the plant unbalances the bonding contract and so on. For example, our Pinellas plant generates 50,000 btu, or enough to run a small city, which we sell to Florida Power. So, if there is a reduction, costs will have to be made up through an increase in the tipping fee. Of course, if the volume of solid waste collection and transport are reduced, that's probable "a wash". But there needs to be some funding mechanism in there.

I have had bill drafting this week draw up some amendments for me which will escheat some of the unclaimed deposits. We didn't have that in the container deposit legislation the last two years when I introduced it. Nor has any other state gotten it yet, although some of the bottle bill states are now trying to do that. In New York, for instance, they have discovered that the unclaimed deposits run about $58 million a year. Now, that is not a small piece of change. It is estimated as nearly as we can get a handle on it that our income would equal that. You've got to remember that Florida has a higher per capita consumption of soft drinks and beer and kinds of beverage containers that end up in litter or solid waste than other states because of our climate and our outdoor activities and the heavy tourist population that comes in. So, even though our population is less than New York, it is reasonable to assume that we might go close to that figure. However, trying to estimate it now, we're using a figure of probably $30 million in unclaimed deposits.

So, the first year in the bill we're going to escheat 50 percent of that which will be about $15 million or approximately what a litter tax would bring in. Only instead of all the taxpayers paying it, it would be the people who don't return their containers. With that $15 million, we're going to do two things. Of course, there has to be some administration, but since the litter stream and the solid waste stream will be reduced to the extent that we'll probably have a savings of somewhere about $50 - $60 million in collection, damage, and so forth, we feel that we don't need that money to clean up the litter then as much as the litter tax. There is a big education program in there too. What we're going to do with one-half of that money is set up a trust fund administered by DER for low interest loans to businesses that would either establish redemption centers, would begin recycling of new materials or would increase their recycling operation. The other half we're going to return to local governments to counteract the cost of this conversion of whatever they have to do for separation and encouraging all kinds of recycling and litter control.

We think that the industry is not going to like it. They don't like the bottle bill in the first place because they're claiming their costs are going to be prohibitive. As nearly as we can determine from all the studies that have been in container deposit legislation, the 1½ cent handling fee that we have included in the bottle bill should be sufficient to cover the retailers costs, particularly if they go to the reverse vending machines which are now available where the machine takes your containers and gives you back your deposit.

In some states now, you know the free enterprise in this great American enterprise system is wonderful, they've even come out with another gimmick where there is a machine that in addition to giving you your deposit back, also issues a cents off products coupon. They're finding where they are doing this that the redemption rate of those coupons is about 50 percent as opposed to those you get in the newspaper or in the mail have a redemption rate of three, four, five percent. The stores like that. So, the retailers would be taken care of.

We're only escheating 50 percent of the unreclaimed deposits the first year because that will give the distributors their start up costs which they need to change the system of a two-way carrier. In many states there have been recycling operations where the stuff never even goes back to the distributor. These operators go around and collect it from the reverse vending machines which read the universal product code by laser and identifies which distributor should be credited with it and the whole bit. They're compacted into bins whose contents are collected and taken directly to the recycling center with the distributor given the proper credit. There are all kinds of very, very effective systems that are in effect in other states that substantially reduces the cost.

But we're going to leave 50 percent the first year. The second year we're going to escheat 75 percent and leave them 25 percent the rest of the time to help recover their costs. But this would be again a closed system where the cost of doing, most of the things we need to do, would be on the people who don't return their containers. That's where it belongs.

It would not only increase the life of (or.reduce the necessity for) landfills, but also resource recovery plants. My own people in Pinellas County tell me that the reduction of the 6-8 percent would increase the life of our plant by about five years before it would need to be expanded again. So, there are all kinds of cost savings.

LANDFILLS AND COMPOSTING

LANDFILLS: PAST, PRESENT, FUTURE

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Landfilling is a method of waste disposal in which solid wastes are compacted within a designated area and covered with a layer of soil at the end of each day's operations. Solid waste is defined as any garbage, rubbish, refuse, sludge, or other discarded material of solid, semi-solid, liquid, or contained gaseous state that derives from domestic, industrial, commercial, mining, agricultural, or governmental operations. Both hazardous and nonhazardous wastes fall under this classification, but landfilling as described herein applies to municipal operations involving nonhazardous waste disposal.

The principal types of solid waste found in municipal landfills are garbage (generated from food production), sludge (produced by water and wastewater treatment; collected in septic tanks, grease traps, and similar operations), and trash (paper, cloth, glass, plastics, tires, debris). Florida regulations require garbage and sludge disposal in Class I or II landfills, while trash and yard debris may be placed in Class III landfills. According to the regulations, garbage must be covered daily, but neither sludge nor trash is so restricted. The requirement for cover is intended to reduce the leachate generation and disease vectors associated with garbage disposal in Class I and II landfills.

The use of cover in landfills is relatively recent. The open dumps of earlier years had few restrictions on the types of waste disposed, and little or no cover requirements or access control. Many accepted industrial wastes containing contaminants that have or are creating major problems. Burning, either spontaneous or deliberate, was encouraged as a waste reduction measure. It wasn't until population growth began increasing rapidly in the post-World War II years that people became aware, as they moved closer to them, of the problems of open dumps: disease carried by rats and flies, odors, trash blown or otherwise carried from the site, and air and water pollution from burning and leaching. Since then, landfill regulations and practices have been changing to mitigate these problems.

Three common techniques for covered landfills in current use are the ramp method, the trench method, and the area method. All use similar techniques in which waste is dumped within a certain area and covered daily with soil taken from nearby. The ramp method uses a high wall as the backdrop for filling activities, the trench method has waste dumped into an excavated trench and covered with soil pushed from the edges, while the area method uses a large area built up in lifts.

These methods all provide waste compaction instead of burning to reduce volume. This also decreases problems with leachate generation and air pollution. The daily cover reduces the odor of the garbage and its attractiveness to rats and flies, and prevents trash from being blown around and off the site. Fences are often provided to hamper airborne movement of waste during the day while dumping operations are going on. Restrictions on the types of waste received and on site access are also prevalent.

Many pollution problems from landfills are a function of the natural anaerobic decomposition that occurs in degradable waste. The rate of decomposition is influenced by the composition of landfill material and its moisture content. Items such as paper, rags, wood, and food wastes degrade rapidly; refractory materials such as glass, metals, rubber, and plastic rarely if ever break down. Certain chemicals, solvents, oils, and paints are also very refractory. Decomposition proceeds most rapidly where garbage is wet and generally peaks after about 2 years, but may continue for 25 years or more.

The products of anaerobic decomposition are gases including methane, hydrogen sulfide, carbon dioxide, carbon monoxide, and ammonia. Methane, while potentially useful as an energy resource, is burnable and explosive if not controlled. Sulfides are generally responsible for landfill odors.

Another potential contamination source is leachate, water which has passed through solid waste and contains dissolved constituents removed from the waste, which it then carries into surface or groundwater. Inorganic solubles include metals such as iron and other salts such as ammonia, chlorides, sulfides, and sulfates. The anaerobic process heightens metal solubility. Organic constituents of leachate include chlorinated solvents (chlorinated ethanes and ethenes present in household products, dry cleaning fluids, degreasing compounds) and aromatics such as benzene, toluene, and ethylbenzene.

Through the leachate, these constituents can move within and out of the landfill into groundwater. While rates of transport vary--chlorinated ethanes often move nearly as fast as water, while pesticides and PCBs are highly bound to soil and other materials and move quite slowly--there is almost certain to be less of an effect with the use of a daily cover.

The federal regulation dealing with landfills (Title 40, Part II, Section 257) is basically a guidance document for defining the difference between landfills and open dumps. Actual operation of landfills in Florida is governed by Chapter 17-7 of the Florida Administrative Code, which has been revised to contain new requirements for closure and construction.

Before July 1, 1985, sites were considered closed, or under final cover, if a minimum of 2 feet of soil, sand, or some other cover material had been placed over the landfill in compliance with its existing permit. After that date, a closure plan has to be submitted in accordance with the revised regulations, and must include a general report on the area and more specific information about potential contamination, topography, and hydrogeology. A plan for groundwater monitoring and investigation of gas migration is required, the extent of closure operations must be defined, and design specifications presented for the operations needed to attain closure in compliance with the regulations. After closure, a professional engineer must certify that it was done in compliance with the plan, and post-closure care must be provided for 20 years (unless the owner can show cause why this period should be reduced).

Other changes in the regulation include construction standards that went into effect on December 10, 1985, specifying use of liners, leachate collection and treatment systems, groundwater monitoring and surface water management plans, gas control systems, site operations plans, and adequate on-hand supplies of cover material. By January 1, 1987, all landfills must be in compliance with these standards, at what will be a substantial financial burden to many municipal governments.

Currently, about 11 million tons of solid waste go into landfills in Florida at an estimated actual disposal cost of $20.00 per ton, or $75,000 per acre. The costs of accommodating the requirements of the revised standards may equal $70,000 per acre for liners, $500,000 capital expenditure for leachate treatment with operating expenses of $50,000 to $100,000 per year, and $50,000 per acre for low permeability cover.

Site closure where major remedial actions are needed will also be very expensive, often even more than the costs for proper operation that the new construction standards will engender. The average cost for closing a typical 20-acre site with a 1,500-foot long contaminated groundwater plume could be $125,000 per acre.

Landfilling will always be a part of any solid waste management system, but major emphasis is being placed on other activities that reduce the volume of waste so disposed. These include recycling, resource recovery, incineration, and energy conversion. By reducing volume, both the economic and environmental costs of landfilling will be better controlled as increasing population growth puts more demands on waste management systems.

SOLID WASTE COMPOSTING

Paper Presented

by

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SOLID WASTE COMPOSTING

Introduction

Composting is a solid waste management system. In composting the organic fraction of the waste is decomposed under controlled aerobic and thermophilic conditions.

Although composting of solid waste can be the primary waste disposal/utilization option for a community, it is more often used in conjunction with other waste management options such as incineration, refuse derived fuel (RDF), recycling or landfilling.

Composting is a volume reduction technology converting organic putresible wastes into a stable humus-like material which can be marketed or reused.

Thus with incineration the removal of sludge, organic materials such as leaves, food waste and other organics will reduce the volume of material to be hauled or handled; reduce the size of the facility; and increase the BTU content of the incoming waste.

Organic material disposed in a landfill could be readily composted. Thus increasing the landfill life as well as eliminated the potential formation of organic acids which result in undersirable leachates. Thus in conjunction with recycling a considerable portion of the solid waste stream could be eliminated from the landfill.

The most commonly used solid waste management option which incorporates composting is refuse derived fuel (RDF) production. The organic fraction which often makes up to 25 percent of the incoming waste stream is composted and eliminated from the landfill.

Composting is practiced to a very limited extent in North America, whereas in Europe the technology is well established. There are over 100 plants in France which produce over 800,000 tons per year of compost. There are 700,000 tons per year of compost produced in Germany, and almost one quarter of Sweden's wastes are composted.

Basic Considerations

Almost any organic material can be broken down by microorganisms provided optimum conditions and sufficient time is provided. Table 1 lists a number of organic materials which we, E & A Environmental Consultants, Inc., have composted.

Rationale for Composting

Composting, or co-composting of diverse waste streams offers several advantages (Table 2) and has certain disadvantages (Table 3) when compared to other waste managment options.

Table 1 Some Materials Composted by E & A Environmental Consultants

- Leaves
- Yard Waste
- Sewage Sludge
- Septage Solids
- Municipal Solid Waste (MSW)
- Food Wastes
- Cannery Wastes
- Oily Wastes
- Pulp and Paper Mill Wastes
- Chemical Industry Sludge

Table 2 Advantages of Co-Composting

- Produce a marketable product or products.
- Can incorporate diverse waste streams (sludge or septage).
- Reduce volume going to landfill from 50 to 90 percent.
- No potentially hazardous wastes to handle.
- Lower capital cost that alternative combustion or incineration processes.
- Good environmental control.
- Process flexibility.
- Easier to site than alternative systems.
- Very high reliability.

One of the major advantages of composting is that a stable, storable, end product is produced. This product, compost, can have a variety of applications as a soil conditioner, a fertilizer base, or other alternative uses depending on the level of preprocessing done.

A second advantage of co-composting is that the biological process (not necessarily the mechanical system designed) has the capacity of accepting a wide variety of liquid and solid waste streams on both a short or long term basis. For example, it is possible to design a system to handle MSW, sewage sludge or septage and seasonal wastes such as leaves or canning wastes. These alternative residues can all be co-composted. However, certain equipment modifications may be necessary to assure adequate processing. It is important to realize that the inclusion of diverse wastes will impact the characteristic of the final product and will therefore need to be evaluated vis a vis the planned disposition of the product.

A third advantage of the compost process is that the volume of material going to landfills can be dramatically reduced from 50 to 90 percent or more. The composting process itself can reduce the volume of MSW in half. It is possible to design a compost system whereby material is composted for volume reduction and improved environmental control. The resultant compost can then be placed in a landfill. As a result of the volume reduction of the MSW, reduction in the need for daily cover, ease of operation, and other factors it is possible with a relatively low technology to more than double what the estimated life of the landfill would have been without composting. On the other end of the spectrum, it is possible to do up front materials handling and separation to reduce the volume of materials going to a landfill to five to ten percent of the incoming waste stream. All the separated material plus the compost would then need to be marketed.

The compost process is very robust and will breakdown most organics to simpler breakdown products, carbon dioxide (CO2) and water (H2O). With normal MSW no hazardous waste by-products would be formed. This can be contrasted with some incineration processes where dioxins are reportedly formed and the ash can contain elevated levels of certain heavy metals.

Compost systems for 250 to 300 tons per day on a single shift operation have a capital cost of between three and ten million dollars depending on the process selected, site conditions, and other factors. This can be up to an order of magnitude less than for some of the other high technologies available such as mass burn facilities.

With composting it is possible to have extremely good environmetnal controls. The process can be enclosed in a building and the air scrubbed with a relatively simple technology to allow composting to

Table 3 Disadvantages of Co-Composting

- Greater space requirements than for combustion systems.
- Labor requirements may be greater than for incineration systems.
- Landfill space must be required for rejects.
- Compost product must be marketed.

occur at a location near the site generation. There is no visible stacks. The process is generally carried out on a covered asphalt or cement pad so there is no chance of groundwater pollution. Because of this and the public perception of composting as a form of recycling, it is frequently easier to site a compost facility than it would be to site a mass burn facility.

On the negative side, composting will generally require more space than will a combustion technology. Also, composting will tend to be somewhat more labor intensive than many of the combustion technologies. However, the level of training necessary to operate a compost facility may be less than would be required for a combustion process. A third disadvantage which is true for all solid waste disposal/utilization practices, to a greater or lesser extent, is that it is necessary to have some landfill capacity available for system rejects of by-products. The final disadvantage is that composting creates one or more products which must be marketed. If a continuous marketing effort is not undertaken then this will cause substantial difficulties. This aspect of composting is covered in more detail in a later section of this paper.

Co-Composting Design Considerations

Figures 1, 2, and 3 show general co-compost process schematics. These schematics give a good indication of the flexibilty of solid waste composting in terms of materials handled and equipment required. The first system entitled minimal processing shows the case where very little materials processing and handling is utilized. In this case no or minimal material processing tasks are performed upstream of the composting process. The raw MSW is placed in windrows or enclosed vessels for a fixed period of time. The output material is then screened with the oversize material going to a landfill and the undersized material either ground or utilized as a soil container. This type of system will produce the lowest quality compost and have the largest volume of material going to a landfill. The primary advantage of this system is the lower capital costs. The actual O & M costs may be even higher. Since there is no preseparation, this results in more material being handled during the composting and at several other stages in the process train. This type of process might be suitable if one is only looking at volume reduction in a landfill. One other disadvantage of this type of system is that it is extremely difficult, if not impossible, to co-compost products such as sewage sludge with the MSW due to the inability to mix the materials adequately. This system could be effective in communities implementing source separation.

The moderate processing flow chart (Figure 2) shows that some rudimentary preprocessing takes place. This preprocessing can include shredding with several types of shredders or grinders. This particle size reaction provides for a much more homogenous product with increased surface area for composting. Since the shredded material comes out in a relatively steady stream, it is much easier

Figure 1 - Minimal Processing - Flow Chart 7

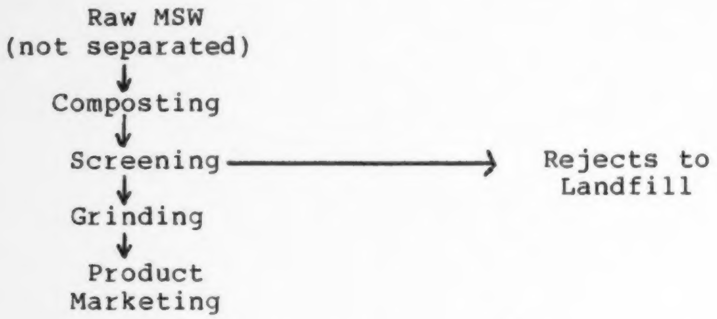

Raw MSW
(not separated)
Composting
Screening
Rejects to
Landfill
Grinding
Product
Marketing

Figure 2 - Moderate Processing Flow Chart

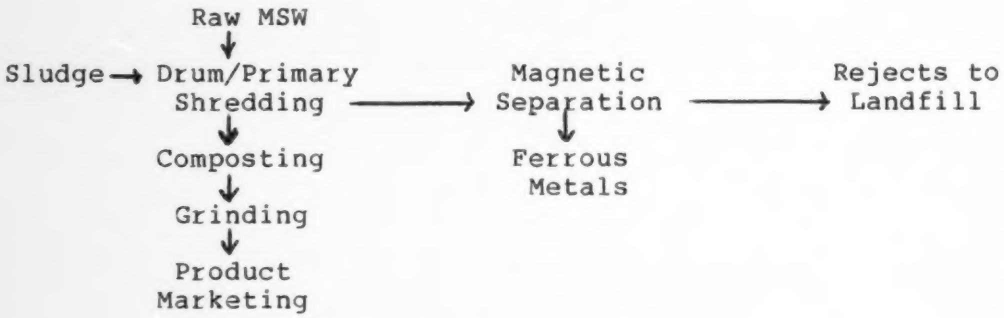
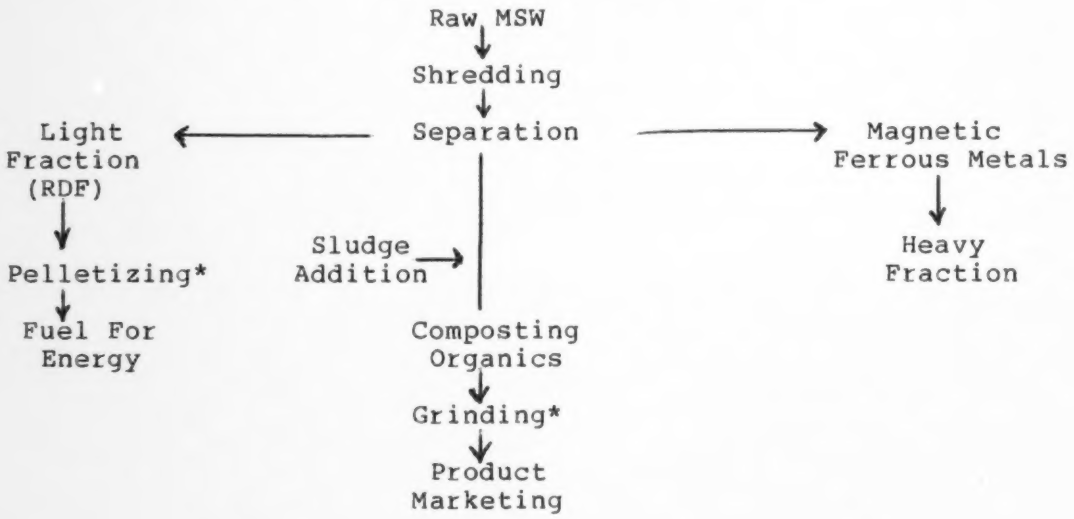

Raw MSW
Sludge
Drum/Primary
Shredding
Magnetic
Separation
Rejects to
Landfill
Ferrous
Metals
Composting
Grinding
Product
Marketing

Figure 3 - Extensive Processing - Flow Chart


Raw MSW
Shredding
Light
Fraction
(RDF)
Separation
Magnetic
Ferrous Metals
Pelletizing*
Sludge
Addition
Heavy
Fraction
Fuel For
Energy
Composting
Organics
Grinding*
Product
Marketing

*Unit process if desired.

to add and mix such materials as sewage sludge, septage, or water. It is also easy and effective to add a magnetic separator to remove ferrous metals from the waste stream. This process will improve the quality of the compost and reduce the volume of rejects going to the landifll. This type of process would require higher capital costs than the minimal processing systems. There are now two products to be marketed, ferrous metals and compost.

The extensive processing flow chart (Figure 3) shows the most capital intensive types of compost systems available. In addition to the grinding step, an up front separation strategy is employed which uses either ballistic separation, air classification, or screening. This can result in multiple products such as glass, RDF, paper, ferrous metals, plastics, or aluminum depending on the strategy or strategies chosen. Because of the up front separation steps, there is a small quantity of higher quality material to be composted. The end result of this is that a much higher quality compost is produced. The decision to choose this type of system will depend on the waste stream, the potential revenue to be derived from the available markets, and the overall system flexibility desired.

There are numerous solid waste composting systems throughout the world. Table 4 shows the various systems E & A Environmental Consultants, Inc. have evaluated. Thus we are familiar with the limitations, advantages and capabilities of these systems. Each of these vendors have different claims for their processes and each system produces a slightly different product or products. This diversity of systems and claims serves to confuse many potential clients as to the applicability of a particular system for their need.

Market/Distribution of Compost and Related Products

The key to a successful compost or compost-RDF facility is to identify the market for the products prior to developing the facility. This will insure that the product(s) produced will meet the needs of the users. If several market sectors are identified then the system should be flexible enough to produce a diversity of products as demand warrants.

Socioeconomic and Economic Issues

The economics of a composting/RDF facility depends on a number of factors. As was pointed out earlier a single shift, 300 ton per day facility would cost between three and ten million dollars. Obviously this facility could process 600 tons per day on a two shift basis with no increase in capital costs. The wide range in costs reflects redundancy and the extent of separation or processing steps. These steps depend on the value of the products and available markets. For example, RDF energy values range from 5000 to 6500 BTU/lb. The cleaner the RDF desired the greater the extent of processing and separation.

Table 4 Some Solid Waste Systems Co-Composting Systems

Evaluated by E & A Environmental Consultants

- Fairfield Hardy
- Taulan Weiss (Weiss-Kneer)
- INGE (Brickollars)
- DANO
- Organic Bioconversion
- Eweson Digestor
- OTV
- Ebara
- American Bioreactor

BAV
ABV
Seerdrum
Heidelberg Silo
Windrow Systems
Static Pile Systems
PLM
Buehler Miag
Tunnel Reactor

There are other important socio-economic issues. These are:

- Smaller, regional facilities can reduce appreciably the transportation costs.

- Unlike mass burn facilities, the economics of scale do not necessarily apply and it is possible to design modular facilities.

- There is no need to operate 24 hours per day.

- Aesthetically the system can be enclosed in a facility which is similar to many industrial or commercial enterprises. No stacks or other unusual structures are visible.

- Redundancy - The composting operation can be handled by typical OPW equipment thus avoiding costly backup equipment and facilities. In comparison, mass burn facilities would require complete redundancy or the availability of a landfill capable of accepting the entire solid waste load.

Summary

Composting of municipal solid waste is a proven technology which after can be the most cost effective. Its flexibility and the capability to handle a large variety of wastes makes it attractive to various community sizes and needs. Thus it is important to consider composting in any solid waste management plan.

COMPOSTING OF WASTEWATER SLUDGE WITH YARD AND WOOD WASTE

By: William Farrell, Nursery Supervisor
Streets & Highways Division
Broward County, Florida

The oldest continuously operating sewage sludge composting facility in Florida was established by the Broward County Streets and Highways Division in 1975.

When the facility was first established, it was originally intended that it only produce horticultural compost for the county tree nursery, which is managed by the Streets and Highways Division. One of the major distinctions of this facility is that it has always been managed with an exclusive emphasis on the end product. This is probably the most important reason why this composting operation has had such a long and successful history.

The compost operation is located on five acres of land adjacent to the county tree nursery. It consists of a one-acre asphalt mixing pad where wood chips and sewage sludge are received and mixed. The adjoining four acres with a crushed rock surface is the active composting and storage area. Appropriate technology and simplicity are the greatest innovative factors at this facility. The simplicity in design and operation creates cost-effectiveness and allows a profit when sold or a cost-free, soil-like material for local utilization.

Compost can be made from virtually any type of organic matter including leaves, yard waste, wood chips, garbage, stable cleanings and dewatered sewage sludge. The two waste materials most often used at the Streets & Highways Division facility are dewatered sewage sludge and wood chips. We take disposal problems and turn them into assets, thereby protecting our environment from pollution and providing sorely needed organic material to improve our soils.

When this operation first began, the wood chips used as the bulking agent were supplied by Streets and Highways Division's tree trimming crews. In 1982, when the amount of sewage sludge received by the facility increased, the need for a greater amount of bulking agent also increased. A readily available source of wood chips is now supplied by private tree-trimming companies who are happy to deliver their waste to the compost facility because tipping fees at the public and private landfills are $60 to $80 a load. Over 25,000 cubic yards of wood chips, that would otherwise be wasted, is delivered to this compost facility each year.

At present, we are receiving sewage sludge from the City of Hollywood's 35 MGD Wastewater Treatment Plant. The sludge is heat-treated and dewatered by the Zimpro process, leaving a 28% solids content, which we found to be ideal for composting when combined with wood chips at a ratio of 3 to 1.

Compost is the product of controlled decomposition of organic matter in the presence of air. We help nature by creating an optimum environment for the compost process to take place.

At the time of delivery, the sewage sludge is placed on a bed of wood chips 18" to 24" thick. The front-end loader mixes the wood chips with the sewage sludge until a good uniform mixture is achieved. It is then placed in the first position, making a windrow about 12' high and 24' across at the bottom, eventually making a windrow 200' long. After windrow number one is completed it is aerated by turning it over into the next position with the front-end loader. This process is repeated every ten days for a total of three aerations.

The composting process is the result of microbial action on the organic material and this action releases considerable energy in the form of heat. When the interior temperature of the compost piles is maintained in excess of $55^{\circ}C$ for at least 30 days, it reduces pathogen levels in the compost and a safe and valuable organic product is produced.

After the last aeration, the compost is moved by truck to the storage area for curing. If the compost is to be used as a top dressing or artificial topsoil, it can be applied after three months of curing. When the compost is to be used as a soilless potting medium, it is generally allowed to cure for at least six months.

The Broward County government receives a revenue of more than $100,000.00 in tipping fees a year from the City of Hollywood charged for the disposal of sewage sludge at the Streets and Highways Division compost facility. The sale of compost by the Broward Soil and Water Conservation District, the county's exclusive marketing agency, will return an additional $60,000.00 through their sales program. This operation then becomes a money-maker for county government.

No expenditure was needed to start this compost facility since we utilized the already existing county property and equipment. Site preparation was accomplished by division's construction crews. A front-end loader, operator and nursery supervisor are funded under the existing budget of the Streets and Highways Division. There was little capital outlay for construction and no additional cost for operation.

Today, many different types of sophisticated and often expensive composting equipment are being marketed. Their high initial capital cost may make the hi-tech approach to composting prohibitive to small municipalities.

A major objective of our project was to utilize, when possible, heavy equipment which would be common to the public works inventory of an average community. Windrow composting could be a viable sludge disposal alternative for other municipalities across the country with limited funds for sewage sludge management programs.

The equipment used at this facility is a front-end loader, the "workhorse" of the operation, and a Omega thermometer with a 36" stem is used for recording compost pile temperatures. Also, two twelve-yard dump trucks are used on an occasional basis. Our newest addition is the sprinkler system we installed last year. Because of the low rainfall throughout the winter months, it is necessary to supply additional moisture to the compost piles in order to maintain optimum composting conditions. There was a great deal of concern initially about the heavy summer rainfall. We have found, from experience, that these rains do not affect the compost process. Good temperatures are maintained during the rainy weather.

The compost produced at Streets and Highways Division's compost facility is a Grade I compost. Grade I is a designation set down by the Florida Department of Environmental Regulation as the highest grade of compost. It can be used in all the areas that are mentioned in this report.

Our compost was used as an artificial topsoil in the landscaping of the new Streets and Highways Division facility. In 1985 alone, over 16,000 cubic yards was used on Broward County roadways for maintenance and new construction. We have supplied Broward County Parks and Recreation Division with compost for their park projects. In addition to furnishing compost to many municipalities for use on their athletic fields and playgrounds, our product has been used by the Soil and Water Conservation District in their beach restoration and revegetation projects. We have provided compost for county historical sites , state hospitals, health department facilities, the housing authority, airport landscaping and apron stabilization, a new county courthouse, library and many other county and state facilities. In addition, our giveaway program assisted Broward County Schools with their horticulture classes, as well as in their landscaping and outdoor classroom projects.

This product has been tested extensively in research projects at the University of Florida with the results published in many professional journals. Its safety and horticultural value have been well documented.

Composting not only produces a viable soil-like product, it has proven to be an invaluable means of a safe and environmentally acceptable disposal method for sewage sludge as well.

For example, prior to 1981, the City of Hollywood, Florida had dumped its sewage sludge at the Broward County Landfill Sludge Lagoon in Davie, Florida. This lagoon was closed in February 1982 because it was found to be leaching into the aquifer and contaminating local wells. Today this disposal site is a major E.P.A. designated Superfund Site which will require millions of dollars to clean up. Ever since the Davie Landfill Sludge Lagoon closed, the City of Hollywood has been delivering their sewage sludge to the Broward County Streets and Highways' facility where it is converted into compost. The sewage sludge that originally contributed to what became a major Superfund Site is now being used to restore our beaches, beautify our highways and many other projects involving the establishment and maintenance of landscapes.

Composting is certainly a much more desirable alternative than the previously used disposal methods.

TOMORROW'S LEADERS: HELPING TODAY

My "talk," intended for children of elementary school age, introduced the topic of recycling as an important option in waste management. It was followed by individuals discussing recycling of aluminum and paper and how to organize recyclables.

Central to my presentation was a picture book, *Where Does the Garbage Go?* by Paul Showers, a "Let's Read and Find Out Science Book" from Thomas Y. Crowall Company (1974).

I read the book to the group, stopping part way through. It is a story told by a young girl. She first talks about what goes into the garbage at her house, including what she herself puts into her waste basket. " Everywhere people live they make garbage and trash. Everybody wants to get rid of it."

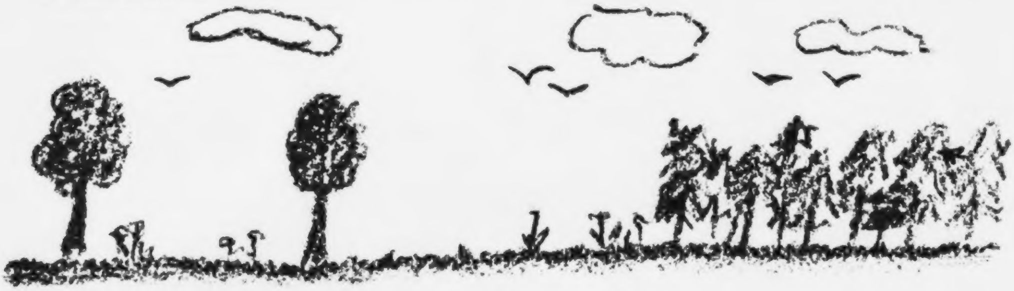
At her house, a big truck collects the garbage. At her uncle's farm, garbage (food scraps) is fed to the pigs, while trash is buried. "There is one big trouble about garbage. People never really get rid of it. They just move it away from their houses to some other place."

Many cities used to dump their garbage into lakes or the ocean. Sometimes it was carried back to beaches wherepeople were swimming. They had to stop dumping it there.

Now, many cities burn their garbage in incinerators, but the smoke makes the air we breathe dirty and ashes are left that have to go somewhere too.

Many other cities send their garbage to a dump-- which is " a great big mess covered with junk...all the things no one wants anymore."

At this point I stopped and directed attention to a simple picture I had drawn in colored chalk on a blackboard.



Through guided questions we decided that under the grass was sand and rock, with a layer of water between two rock layers, which I drew in.

Some people decided it was such a pretty place that they built a couple of houses so they could live there. Since everyone needs water, they dug wells down to the water layer under the ground. Everyone also makes garbage, but no one wants it near their homes. So the people cut down some of the forest (I erased some forest trees, birds, and ground) to make a dump.

More people moved in (I drew some more houses and wells), made more garbage, and had to expand their dump (erased more trees and earth closer to water table).

Of course it rained sometimes (drew streams from clouds) on the homes and on the dump. Where does the rainwater go? Through the sand to the water layer, through the garbage to the water layer.

One day the people noticed something about the water coming out of their wells. It didn't look dirty (I held up a jar of water mixed with dirt). It looked fine, but it smelled funny. Maybe it smelled like this (passed around a jar containig water and a small amount of white vinegar) or this (a jar containing water and rubbing alcohol). Would you want to drink this? What had happened to their water?

If dumping garbage into the ocean is not a good way to get rid of it, and burning it causes other problems--like smoke in the air-- and burying it isn't a good idea, what can we do with garbage?

I returned to the book, page 26, which discussed turning old cans into new ones, old bottles into new glass, and old paper into new paper. I introduced the word "recycling."

The book concluded with the girl saying "Each one of us could help by not making so much trash," retrieving a toy from her waste basket, and refurbishing it.

We then emptied out a bag of trash and decided what might be recycled.

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